Popular Science

SM

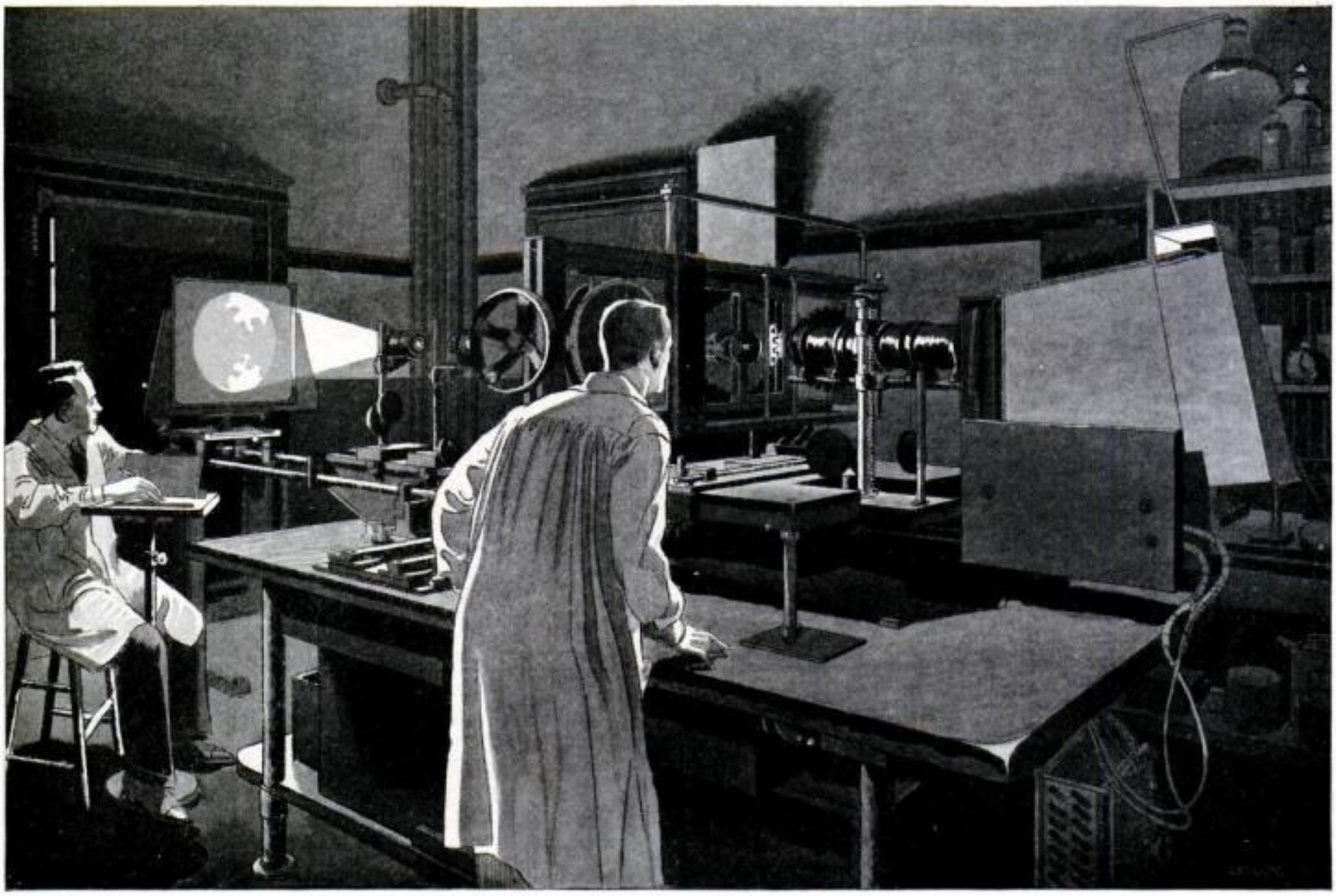
MONTHLY Founded 1872

August
1929
25 cents

New Ideas: Aviation ~ Radio ~ Automobiles ~ Home Building
Engineering ~ Exploration and The Home Workshop

WHAT WESTINGHOUSE IS DOING IN RESEARCH

DRAWN FOR WESTINGHOUSE BY C. PETER HELCK



WESTINGHOUSE MEASURES INTERNAL STRESSES IN MACHINE PARTS WITH THIS LIGHT-PROJECTION MACHINE

Tomorrow's electrification--on view today

Spend today with Westinghouse research engineers and catch a glimpse of what Westinghouse is doing toward meeting tomorrow's electrical requirements . . .

In a quiet wing of the laboratories in East Pittsburgh, slightly pungent with the fumes of mysterious chemicals, specialists are applying electricity to chemistry. Time alone can tell what new electrical principles they will uncover to aid the industries that depend on chemistry for their advancement.

A cathode ray tube sputters in a dark corner. We know it as the greatest concentrator of energy man has yet developed. Nothing can live in the path of its rays. Westinghouse research is seeking its commercial value.

Here we find men working on new insulators for higher voltages, and new insulators with metallic glaze making it possible to solder cables securely to porcelain. There they are applying unusual tests to find the dynamic strength of metals, and the amount of permanent distortion they may undergo at high temperatures. Again they are developing inexpensive iron-base alloys to take the place of platinum in tubes and cells.

Now we are among the grid-glow tubes and photo-electric cells. These super-sensitive tubes are the keys to automatic traffic controls, fire and smoke detectors, counting and sorting devices that need not touch their subjects, and switches that will turn on lights automatically when daylight wanes. Thus Westinghouse research is ever looking forward, alert to the future needs and possibilities of every application of electricity —leading the way to new economies for industry and new conveniences and comforts for the home.

Westinghouse Electrification
Appliances Apparatus
Wiring

The Sign of a Westinghouse Dealer

Westinghouse

USED CAR ADVANTAGES *Offered By* CADILLAC-LA SALLE *Dealers*

IT IS rather significant that the Used Car business of Cadillac-La Salle dealers is more active than it has ever been in Cadillac history and the largest in volume.

Quick turn-overs in Used Cars mean the buyers have discovered advantages that cannot be ignored. Certainly when Used Cars move rapidly out of the showrooms into the hands of eager buyers there must be an important reason.

What are these Used Car advantages that are offered by Cadillac-La Salle dealers?

For one thing, the Cadillac-La Salle dealer has placed his Used Car department on an equality with his new car department,—

Which means not only that the cars are well conditioned and ready to deliver satisfactory service, but that the sale of a Used Car is surrounded with all the safeguards for the purchaser that a reputable dealer can provide.

It becomes a matter of accurate information concerning the status of the car — proper pricing — fair dealing.

Bear in mind also that there is a remarkably strong trend to new Cadillacs and La Salles. Buyers of new cars have discovered, for example, that it is practically as easy to buy a Cadillac-built La Salle as it is to purchase a car of lesser quality and prestige.

For only a little more a month (La Salle is priced as low as $2275 F. O. B. Detroit) they can enjoy what no other car — excepting Cadillac itself — can give them — the 8-cylinder superiority of the famous Cadillac-La Salle 90-degree, V-type power plant and invaluable features of handling-ease and safety exclusive to Cadillac-La Salle.

The market value of the cars they turn in is frequently sufficient for the down payment and they take care of the balance in easy monthly payments by employing the convenient banking service of the General Motors Deferred Payment Plan.

And so, because of this widespread trend, Cadillac-La Salle dealers have an exceptional variety of good cars of standard makes among their Used Cars. As there have been no forced sales these trade-ins have been accepted at reasonable market prices.

There is no excess to pass on to the Used Car buyer. Values are exceptionally high.

Consequently the Cadillac-La Salle dealer is in an enviable preferred position for the sale of Used Cars, as well as new cars, and the public's recognition of this fact is the reason why these dealers are enjoying a remarkably active Used Car business.

CADILLAC-LA SALLE

CADILLAC MOTOR CAR COMPANY

Division of General Motors

DETROIT, MICHIGAN OSHAWA, CANADA

WHAT IS NEW THIS MONTH

Table of Contents for August

LEADING ARTICLES

SPECIAL FEATURES

Astronomy

Automobiles

Aviation

Engineering

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Exceptional People

Health and Hygiene

Laboratory Discoveries

Nature

New Devices for the Home

New Processes and Inventions

Photography

Radio

Ships

Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

In This Issue—Hundreds of Fascinating Articles Tell the Latest News of Laboratory Discoveries, Scientific Triumphs, and Amazing New Inventions

A $15,000 "TRIFLE"

Frank Ditmar applies simple arithmetic to his investment program and learns the true value of 2% extra

By WALLACE AMES, *Financial Editor*

I

"I guess I am just a sap," mourned Frank Ditmar one evening the first of the month. He had drawn his salary, made a deposit in the savings account and was looking at the red ink figures representing interest credits.

"What makes you talk like that?" inquired Mrs. Ditmar.

"Look at this bank book and you'll see," said Frank. "We'll never get anywhere at the rate we are going. For two years we have been depositing $50 in the bank regularly each month. What have we to show for it? The magnificent sum of $1,251. In two whole years the interest on our savings has amounted to only $51. At that rate we will not be able to retire on an independent income, even if we live to be 100 years old."

"You are no sap," replied Mrs. Ditmar. "You are just a little impatient. We may be worth only $1,251 now, but I for one am mighty glad we have that much in the bank. Aside from a nest egg for the 'rainy day' we have formed the habit of saving and that is worth a lot—a whole lot more than the $51 interest our savings have earned to date."

"Just the same," insisted Frank, "I wish we were getting ahead faster."

II

For fully a week Frank Ditmar held to the same attitude toward his family's financial future. Getting ahead by regular savings and nominal interest continued to seem like slow, discouraging work. But a surprise was in store for him.

"I made a date for you tonight," announced Mrs. Ditmar, when her husband came home from the office. "The representative of a firm of investment bankers was here today. Mrs. Reid suggested that he call on us. He has a proposition that the Reids have become very much interested in. It sounded so good to me that I asked him to return this evening and talk with you. After you have heard his story I think you will get some new ideas regarding our money problems."

At eight o'clock Mr. Fisk, the investment salesman called. He explained the principal details of a security that paid 6%, but Frank Ditmar showed a minimum of interest. "What's 6%?" Frank argued. "That's only 2% more than we are getting now—just $20 a year on $1,000. A mere trifle—not worth bothering with. I'd just as soon plug along at 4% as to get 6%. Unless I see a chance to make a killing we might as well stick to 4% bank interest and reconcile ourselves to the fact that we will never get rich. And I have just enough common sense not to risk what money we have in any get-rich-quick scheme."

"You are just the type of man I like to talk to," said the investment salesman. "As you know, this 6% security is a sound investment—not a get-rich-quick scheme. I cannot promise you sudden, fabulous wealth if you make this investment. But the 2% extra that you get over 4% bank interest means a lot more to you than you realize. Did you ever try to figure out what 2% extra means to you?"

Frank admitted that he had not. It just seemed to him an inconsequential trifle—$20 a year on $1,000 as he had already mentioned.

"It may surprise you," suggested Mr. Fisk, "to learn that 2% extra may mean thousands of dollars greater independent wealth. It may mean gaining financial independence as many as five to ten years quicker."

"That begins to (*Continued on page 5*)

FINANCIAL WORTH AT AGE 60

Through Quarterly Investment of Various Amounts (Interest Re-invested)

Comparing 4% and 6% Quarterly Compound Interest

Starting at	$150 Quarterly			$225 Quarterly			$300 Quarterly		
	4%	6%	Gain at 2% Extra	4%	6%	Gain at 2% Extra	4%	6%	Gain at 2% Extra
Age 25	$45,861	$71,454	$25,593	$68,791	$107,181	$38,390	$91,721	$142,908	$51,187
30	34,851	50,479	15,588	52,276	75,658	23,382	69,702	100,877	31,175
35	25,828	34,835	9,007	38,742	52,253	13,511	51,656	69,671	18,015
40	18,433	23,250	4,817	27,650	34,875	7,225	36,866	46,500	9,634
45	12,373	14,649	2,276	18,559	21,973	3,414	24,746	29,297	4,551
50	7,406	8,262	856	11,109	12,393	1,284	14,813	16,525	1,712

Through Single Investment of Various Amounts (Interest Re-invested)

Comparing 4% and 6% Quarterly Compound Interest

Starting at	$2,500 Investment			$5,000 Investment			$10,000 Investment		
	4%	6%	Gain at 2% Extra	4%	6%	Gain at 2% Extra	4%	6%	Gain at 2% Extra
Age 25	$10,068	$20,100	$10,032	$20,136	$40,199	$20,063	$40,271	$80,398	$40,127
30	8,251	14,923	6,672	16,502	29,947	13,445	33,004	59,693	26,689
35	6,762	11,080	4,318	13,524	22,160	8,636	27,048	44,320	17,272
40	5,542	8,227	2,685	11,084	16,453	5,369	22,167	32,906	10,739
45	4,542	6,108	1,566	9,084	12,216	3,132	18,167	24,432	6,265
50	3,722	4,535	813	7,444	9,070	1,626	14,888	18,140	3,252

A $15,000 "Trifle"

(Continued from page 4)

sound interesting," said Frank, "if what you say is true. Can you prove it?"

"Sure I can prove it—prove it by simple arithmetic. That's just why I came here tonight. This little black book contains a lot of interest tables, showing how money grows at various rates of interest for different periods of time.

"First let us look into the matter of doubling your money. According to the table, $1,000 at 4% interest, compounded every three months, grows to $2,007 in 17½ years. At 6% interest, compounded every three months, the same $1,000 doubles itself, to be exact, grows to $2,013, in *11¾ years*. 2% extra may seem like a trifle to you, yet that trifling difference in your favor shortens by 5¾ years the length of time required to double your money.

"Now let us figure out another calculation. Since it takes 17½ years to double your money at 4% quarterly compound interest, how much *more* than double your money would you have in 17½ years if you got the 2% extra—6% instead of 4%? According to the book you would have $2,835. In this example the 'trifling' 2% extra means $828 in your pocket. You may spurn $20, the difference on $1,000 in a year, but $828—that's a different matter."

"Yes," agreed Frank; "that begins to amount to something. I did not realize that such an insignificant difference could pile up to such figures, or mean so much in time saved."

"Since you are interested suppose we carry this mathematical study a little further," suggested Mr. Fisk. "Let us find out what the 2% extra means on monthly amounts of $50." A little figuring produced the following comparisons:

$50 MONTHLY
Quarterly Compound Interest

	4%	6%	Gain at 2% Ex.
5 Years..	$3,325.00	$3,503.00	$178.00
10 Years..	7,382.00	8,221.50	839.50
15 Years..	12,332.00	14,576.50	2,244.50

"Possibly," suggested Mr. Fisk, "you would not get excited over the prospect of gaining $178 in five years, representing 2% extra for that period on a $50 monthly investment. But you can't lightly pass up the chance to gain $2,244.50 which is the 2% extra in 15 years. This last calculation demonstrates how rapidly your gain accelerates with the passing years."

"That's almost unbelievable," ejaculated Frank Ditmar. "$178 gain in five years and $2,244.50 gain in 15 years—without increasing the monthly investment! But the figures are there. I guess they must be true."

"Let me draw one more mathematical picture," requested Mr. Fisk, "a picture of your comparative financial worth at five year intervals up to the time you are 60 years old, assuming that from now until then you save $50 monthly and invest it each three months in units of $150. How old are you now?"

"Thirty," an- (Continued on page 6)

A $15,000 "TRIFLE"

(*Continued from page 5*)

swered Frank. A little more figuring produced the following table:

$150 QUARTERLY

Comparing 4% and 6% Compound Interest

	4%	6%	Gain at 2% Ex.
At Age 35 . . .	$ 3,336	$ 3,521	$ 185
At Age 40 . . .	7,406	8,262	856
At Age 45 . . .	12,373	14,649	2,276
At Age 50 . . .	18,433	23,250	4,817
At Age 55 . . .	25,828	34,835	9,007
At Age 60 . . .	34,851	50,439	15,588

"Just look at that 'gain' column!" exclaimed Frank. "It goes up thousands of dollars every five years."

"Yes," remarked Mr. Fisk, and you will note that the trifling 2% extra is a neat $15,588 when you are sixty years old."

"Some trifle!" was all Frank could say. "You have sold me. Now let us lay out a program of investing so I can get the 2% extra."

The figures used in this investment story were taken from a compound interest book. In actual practice no investor would achieve the actual results shown. If a few days' delay occurs in making monthly or quarterly investments, if the exact amounts referred to in the examples are not invested, if investments are made in securities which pay a little more or a little less than an even 6%, or if any other similar irregularity takes place, the final result is altered. However, the practical result of getting 2% extra—6% instead of 4%—is demonstrated by the figures worked out by Mr. Fisk. They correctly show what a surprising difference 2% makes over a period of years.

The moral of this story is as applicable to the man or woman with several thousand dollars accumulated as it is to the one who is just starting to build his fortune. Of course, the larger the sum invested the more important the 2% extra becomes, but it is an important item, even in small amounts, as Frank Ditmar learned.

It would not be sound judgment for Frank Ditmar to take all his money out of the savings bank and invest it in securities. POPULAR SCIENCE MONTHLY has always advised its readers to keep a nest egg in the bank for emergencies. But since Ditmar had a snug sum in the bank he very properly started on a long term program to gain the 2% extra that he could obtain from sound securities.

One may be inclined to think of investment in securities in terms of thousands rather than hundreds of dollars. As a practical matter it is just as easy to invest in hundred-dollar units, or even smaller amounts. You can buy one share of stock a month, or two shares, or three—any number that you have money on hand to pay for. Or you can arrange through many investment banking firms to invest on the partial payment plan, spreading your payments over a period of ten months or so.

At the beginning of this article appears a table which helps you to figure out what the 2% extra may mean to you when you reach age 60, either on an investment or a single large amount or quarterly investments of a smaller amount.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

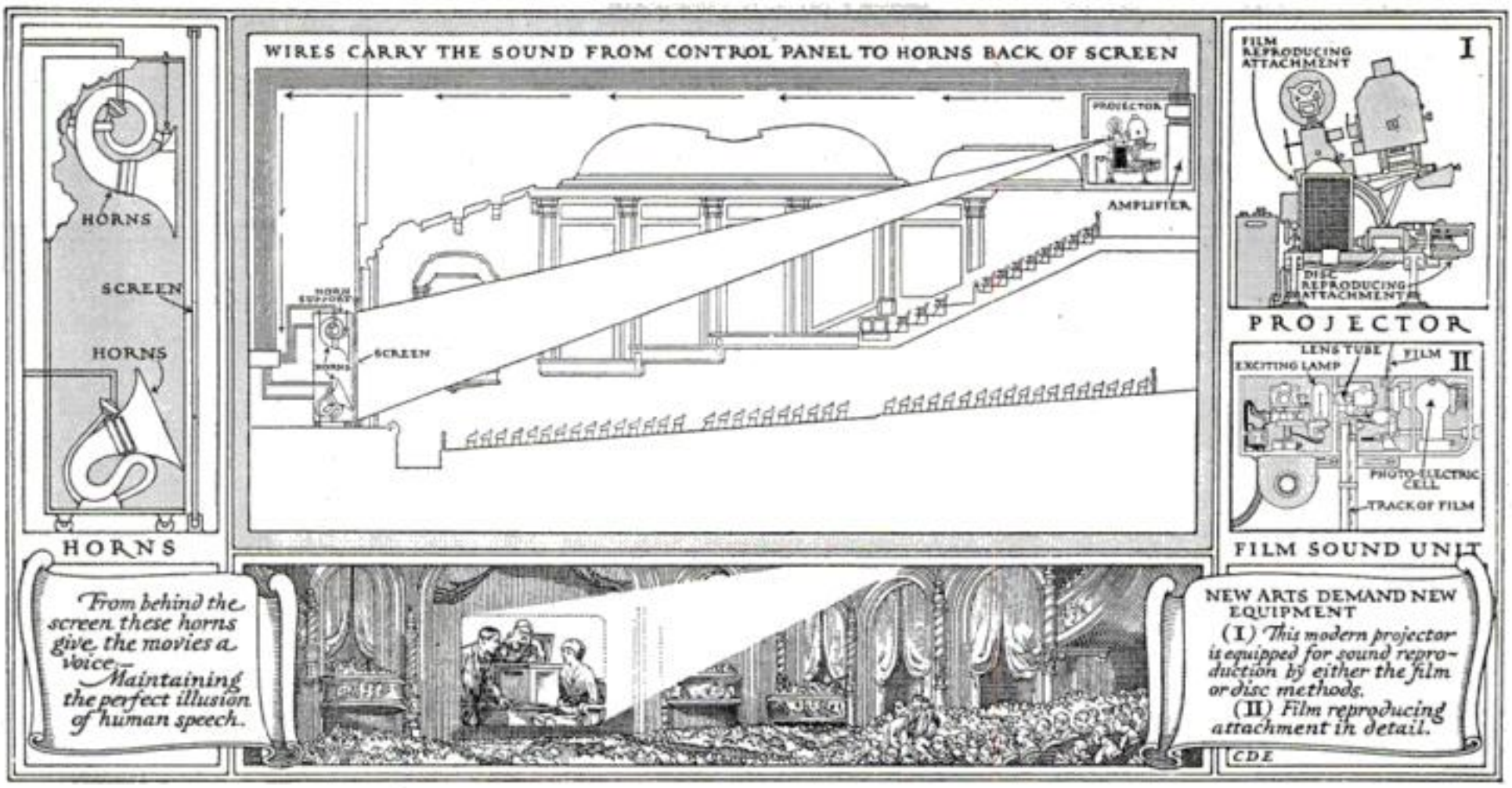
How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

Four-Year Analysis of Financial Investing Co. of New York, Ltd. In charts, diagrams and statistical tables, this booklet analyzes the first four years of operations of one of the older of American general management investment trusts. Published by Smith, Reed & Jones, Inc., 1405 Chase National Bank Building, New York.



WHAT MAKES THE PICTURE TALK?

Your enjoyment of a Sound Picture depends largely on the quality of apparatus used. It pays to go to theatres equipped by the makers of your telephone — the Western Electric Company


A


B


C

WHEN you go to hear a Sound Picture you wish to be certain that the voices will be clear and natural; that the musical accompaniment and the sound effects coming from the screen will be thoroughly pleasing.

Near you is probably at least one theatre which assures just that, because it is equipped with the Western Electric Sound System. This apparatus, made by the makers of your telephone, is installed and inspected by engineers trained in this new art.

The reliable quality of this Sound System has been recognized by over 2,000 theatre exhibitors — exhibitors who have a habit of considering their patrons' satisfaction and who therefore believe that it is worth a little extra investment to secure equipment of proved results.

In selecting Western Electric these exhibitors knew that the correct transmission and reproduction of sound is an extremely difficult problem, as is evidenced by the wide differences in quality between various radios and phonographs. They knew that it was Western Electric's experience with this very problem which, after years of unsuccessful effort by others, finally made Sound Pictures possible.

This same organization which brought the telephone to its present excellence will likewise constantly seek to improve Sound Picture apparatus still further.

To Theatre Exhibitors

People know good Sound reproduction when they hear it. They are quick to appreciate the high quality assured by Western Electric equipment. If your theatre is thus equipped you will render a service by displaying that fact in your advertising and in lobby and outside signs. For additional information address Electrical Research Products, Inc., 50 Church Street, New York.


A


B


C

The sensitive Sound Picture microphone (C), designed for studio recording. A development of the broadcasting microphone (B) and the telephone transmitter (A), indicating how "Sound Pictures came out of the telephone."

The loud-speaking horn (C), a marked improvement for Sound Picture purposes over the cone loudspeaker (B). It is a direct descendant of the familiar telephone receiver (A), and is made with the same care.

Western Electric

THE VOICE OF ACTION

SOUND SYSTEM

INDEX
Guaranteed Advertisements

Automobiles and Accessories

Building Materials

Books

Things to Make

Investments

Tools and Shop Equipment

General

Watches and Jewelry

Hardware Supplies

Smoking Materials

Razors, Toilet Articles, Etc.

Educational

Popular Science GUARANTEE

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

THE PUBLISHERS

Radio Apparatus

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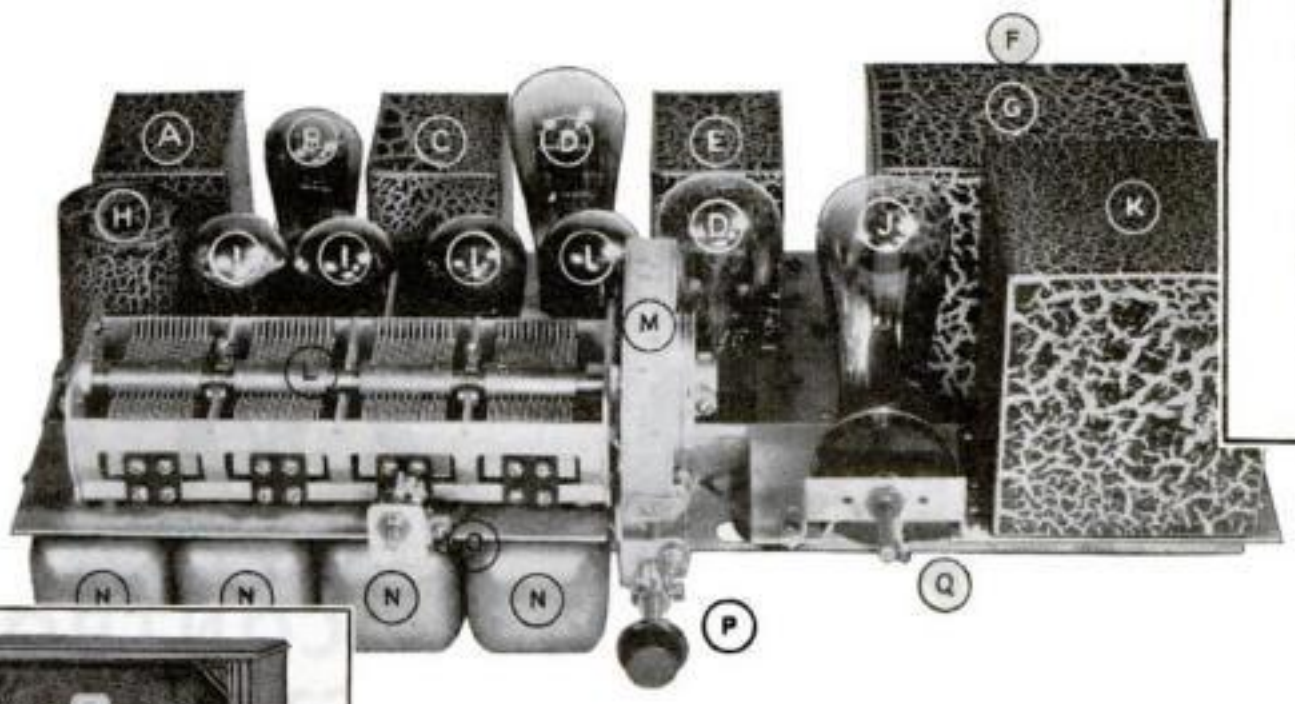
Today...in selecting radio...look for *ENGINEERING*



Directly above is the 9-tube Day-Fan Radio in a new and particularly pleasing small Console of walnut. With specially matched Dynamic speaker, complete except tubes, $169.50.

At upper right, the deluxe Console, a cabinet of rare beauty, constructed of walnut with matched burl panels. Sliding doors. With specially matched Dynamic Speaker, complete except tubes, $225.00.

Here's a Champion of quality in construction

What's the real difference between ordinarily good radio and *excellent* radio today? You've got to go deeper than the looks of the cabinet to find out.

The difference lies in features of electrical and mechanical design—finer workmanship—better materials: *expert engineering.* These things are not spectacular, but they contribute directly to the set's performance and stability.

Day-Fan, in order to achieve a new and delightful *brilliance* of tone, improved selectivity, increased power and amazing volume without distortion—is spending more money in the manufacture of its chassis than ever. (And yet we have reduced the prices of the sets.)

Day-Fan has always been noted for superiority in its audio amplification system, which directly affects the quality of tone. To this superiority there have now been added further improvements.

Two of the new highly efficient UX-245 Power tubes (D, above) are used in push-pull amplification. They deliver great undistorted output to the speaker. Each part of the amplifier, including the specially designed dynamic speaker, is carefully matched in impedances, one with another. This is responsible for full flow of undistorted power, preserving the beauty of tone.

Throughout, the new Day-Fan set is distinguished from average receivers by greater amounts of material, closer limits in manufacture, careful matching of units, and painstaking adjustment of the whole set. Variable tuning condenser (L) is large and rugged. In transformers, coils, chokes, condensers and other hidden parts, the standard is "only the best", with each unit ample in size for its work.

No wonder Popular Science Institute of Standards, scientifically testing radio performance, confers on Day-Fan Radio its unqualified approval.

DAY FAN

FULL-POWER-UTILIZING 9 TUBE RADIO

Day-Fan Electric Co.,
1708 Wisconsin Blvd., Dayton, Ohio

Please mail me descriptive literature on Day-Fan Radio. Tell me where I can hear demonstration.

.....

.....

.....

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

ARE YOU STILL PLAYING "BLIND MAN'S BUFF"

FOR YEARS . . . ONE OF THE LARGEST COLD STORAGE PLANTS IN CHICAGO . . . DEPENDED ON THE ENGINEER'S SENSE OF TOUCH OR FEEL—:BLIND MAN'S BUFF:—TO DETERMINE THE "RIGHT" TEMPERATURE FOR AMMONIA GAS

Tycos TEMPERATURE CONTROL INSTRUMENTS

Science has developed heat treating for metal-baking processes for finishing and innumerable other processes in industry in which temperature control is not only an essential part but in many instances the foundation.

Temperature controlling instruments are a prime necessity in Industry today. *Tycos* Temperature Indicating, Recording and Controlling Instruments are recognized as the "Standard" equipment in America's largest plants.

Cheap instruments are no further removed from "Blind Man's Buff" than is the human element of engineer's touch. *Tycos* Instruments are "Accurate"—and built to deliver enduring satisfactory operation with minimum maintenance.

Don't play Blind Man's Buff—install the recognized "Standard" Tycos Instruments.

IN EVERY INDUSTRY— *Tycos* Temperature Instruments are the "Watch Dogs" of maintained quality. In many instances they are the basis of manufacturing processes—*and they always deliver the goods.*

Tycos in Aviation

A full line of Aviation Instruments for ships and air ports.

Tycos for the Home

***Tycos** Office Thermometers*
An aid in promoting human efficiency.

***Tycos** Bath Thermometers*

***Tycos** Home Set*
Bake Oven Thermometer, Candy Thermometer, Sugar Meter. The secret of accurate results in cooking.

***Tycos** Wall Thermometers*
To help you to maintain a temperature in your house conducive to good health.

***Tycos** Quality Compasses*

***Tycos** Fever Thermometers*

***Tycos** Stormoguide*
Forecasts the weather twenty-four hours ahead with dependable accuracy.

***Tycos** Hygrometer*
To enable you to keep the humidity of the atmosphere in your home correct at all times.

Tycos for the Medical Profession

***Tycos** Sphygmomanometer, Recording Pocket and Office types.*

***Tycos** Fever Thermometers.*

Your dealer will show them to you. Ask us, on a postal, for booklets on any of the above.

Bulletins on request

TO MANUFACTURERS: If you are a manufacturer of any product that goes through heat treating processes in its preparation there are undoubtedly *Tycos* Instruments for Indicating, Recording or Controlling heat that will save money for you in your plant and give you the assurance of the uniform quality you are always striving for.

Informative literature on any type of instrument will be sent you promptly on request, or our engineer will consult with you on the application of *Tycos* to your particular manufacturing problem.

Taylor Instrument Companies

Main Office and Factory
ROCHESTER, N. Y. - - U. S. A.

Canadian Plant: *Tycos* BUILDING, TORONTO
SHORT & MASON, Ltd.
Manufacturing Distributors in Great Britain

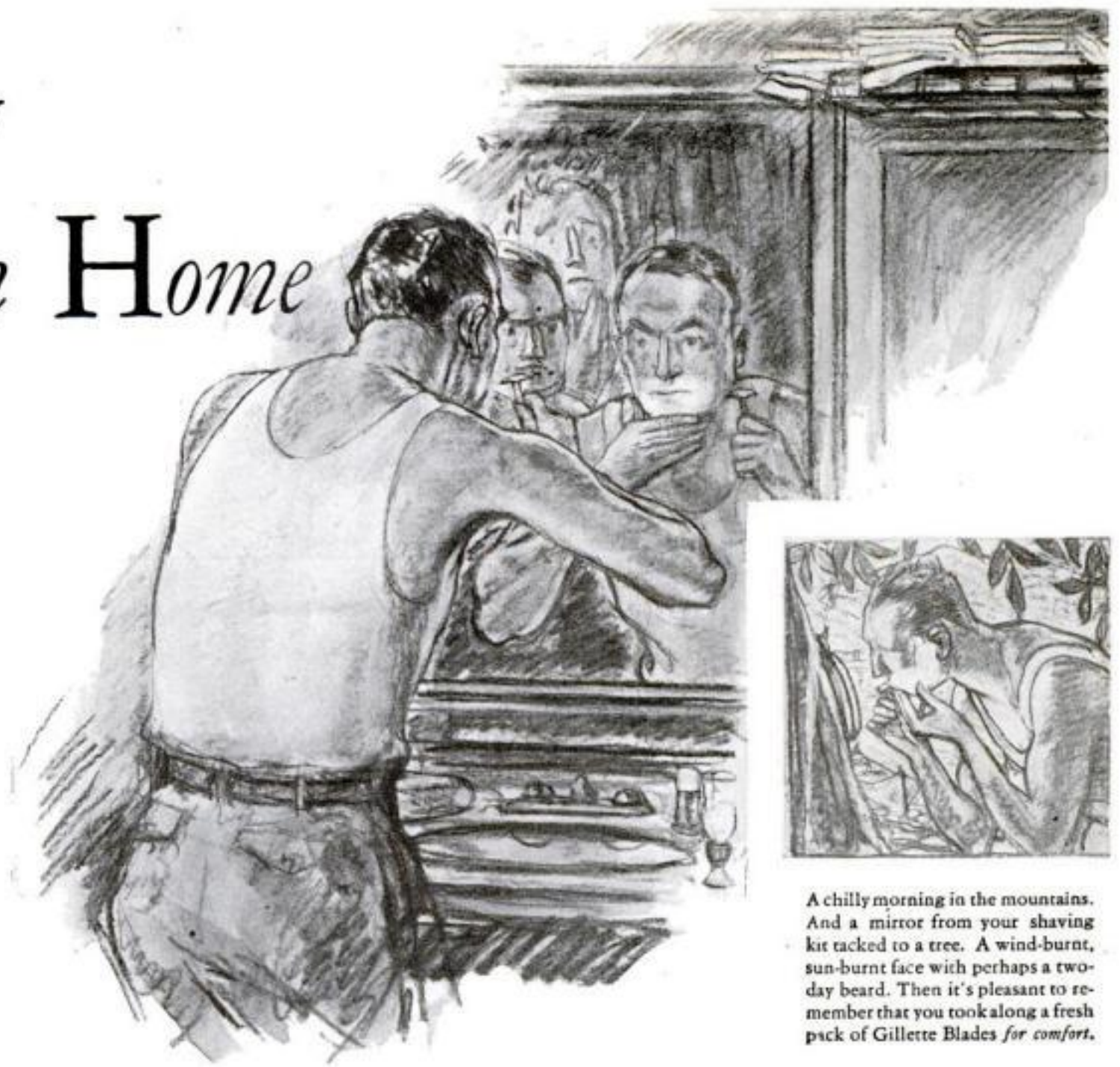
THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING · RECORDING · CONTROLLING

Away *from* Home

Here you are in your *own* bathroom. A place for everything, and everything in its place. Hot water always, a good mirror, and a fresh package of Gillette Blades on the shelf. Then it's easy to get your full measure of comfort.



A chilly morning in the mountains. And a mirror from your shaving kit tacked to a tree. A wind-burnt, sun-burnt face with perhaps a two-day beard. Then it's pleasant to remember that you took along a fresh pack of Gillette Blades *for comfort.*

. . . you can't expect as smooth a shave

WHETHER you shave quietly and luxuriously at home; or strenuously, over the shoulders of other harassed travelers in a Pullman washroom; or primitively in camp, with the cold lake for your wash basin—no matter how different the shaving conditions may be—put a fresh Gillette Blade in your holder and you're sure of a smooth, comfortable shave.

Your guarantee of this unchanging comfort is the careful honing, the delicate stropping that Gillette's marvelous machines give every blade. No human hand, however expert, however patient or tireless, could

But you can count on your Gillette Blade to give you a comfortable shave anywhere

ever work such comfort into a blade.

And Gillette goes one step further. It sets aside almost half of all its blade department workers to do nothing but inspect your blades—and rewards with a bonus the endless search for any blade that may be below par.

You see, eight out of ten men in America shave with a Gillette and expect every Gillette Blade to do its duty. So every blade *has* to be good, no matter how difficult the conditions it goes up against—hard water, cold water, tough beards, tender skins, slapdash lather—a dozen varying conditions that affect the comfort of your shave. Conditions change—the blade doesn't. That's why you can always slip a fresh Gillette Blade in your razor and enjoy a swift, sure shave wherever you are. Gillette Safety Razor Co., Boston, U. S. A.

King C. Gillette

THE only individual in history, ancient or modern, whose picture and signature are found in every city and town, in every country in the world, is King C. Gillette. This picture and signature are universal sign-language for a perfect shave.

Gillette

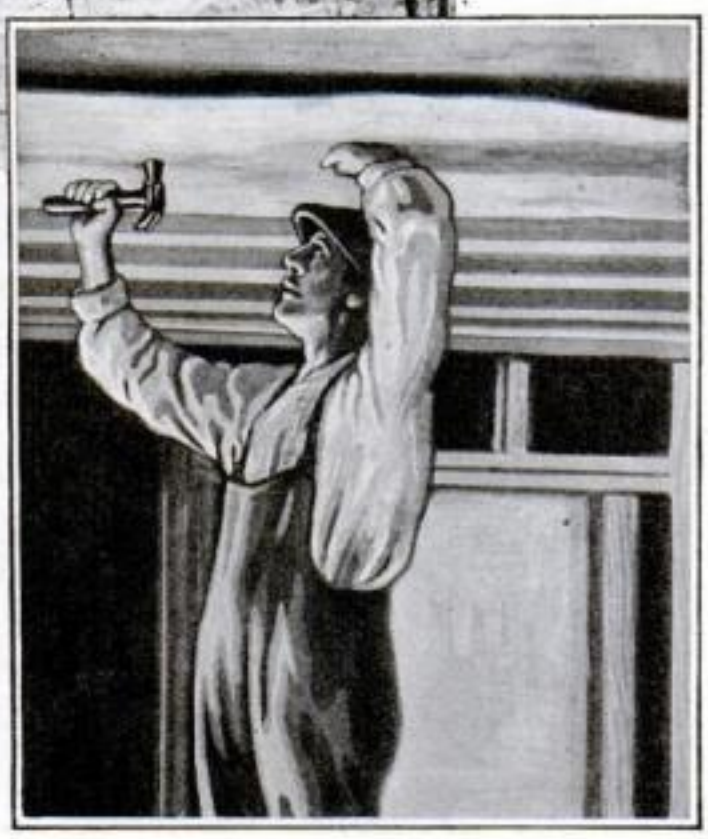
Gillette

What Insulation Really Does

The Right Materials Cut Fuel Bills in Winter and Keep You Cool in Summer

By COLLINS P. BLISS
Director, Popular Science Institute

House at right is insulated; the other isn't. See how escaping heat has melted snow on roof.



Applying insulating material of the felt type to the ceiling of a room—for saving and year-round comfort.

WHEN is a house *really* insulated? Just what will the insulation do? These are points on which there is considerable confusion among people who are building or buying a home. Very frequently they think they are getting an insulated dwelling when, as a matter of fact, they are not. Still more frequently, they know nothing at all about insulation and entirely overlook this very important feature.

By including a sufficiently thick layer of one of the standard insulating materials in the roof and walls of a house, it will bring down fuel costs about one third, make possible the use of a considerably smaller heating system, afford uniform room temperature with elimination of drafts, and keep upstairs rooms ten to fifteen degrees cooler than outside temperature in summer. This is too good a thing to be ignored by the up-to-date builder, and Popular Science Institute, in line with its policy of promoting the use of efficient and modern methods in house construction, aims to increase the knowledge of, and use of, insulation.

COMPARATIVELY few people really know the facts about insulation. A letter that shows how easy it is for many people to be misled on the matter of insulation came from one of our readers the other day. This reader is building a home and is much concerned about securing good construction. To his letter he adds this postscript:

"P. S. Builder claims that house has been completely insulated by the use of two thicknesses of building paper under clapboards and shingles."

His builder was probably honest, but not very up-to-date. The type of construction described was considered at one time "insulation," but today there are materials on the market only a half inch thick that are as effective as ninety-five layers of building paper in stopping heat leakage. So this reader's two thicknesses of building paper will not afford much insulation, as measured by modern standards. Building paper, however, does have a very definite place in good house construction. It stops *air* leakage, though it does not take the place of an insulator which stops *heat* leakage. Building paper should be considered merely as a desirable addition to insulation and not a substitute.

Another material that used to be considered a good insulator was back plaster, but the way in which this really served was as a wind-stopper. A material that is merely air-tight is not enough; rubber coats and window glass, for example, are useful wind-stoppers but let heat go through quite readily.

There are still a number of people—even architects and building contractors—who believe air spaces to be highly effective in preventing heat loss. Scientific investigations conducted by authorities have definitely proved, however, that the value of air spaces as insulation is slight and that air spaces greater than three quarters of an inch in width give no additional value for heat insulating purposes. Heat will go through an air space about three times as readily as through a half inch of good insulating material. An air space in the construction of walls or roof should not be expected to afford sufficient insulation in itself, though air spaces are to be taken advantage of when possible in the application of insulating material.

TO GET real insulation, it is necessary that the roof and walls of a house contain a standard insulating material in a thickness recommended by the manufacturer. There are now a number of good insulating materials on the market in various forms from which the builder may choose. Samples may be seen at local building supply firms and a selection made of a material most suitable for the purpose. In making a choice, consider the cost of the insulation itself in the proper thickness, the cost of having it applied, and how well it suits structural requirements.

A booklet, "Insulation in Building Construction," can be obtained from Popular Science Institute at twenty-five cents a copy. In sending for this, or asking any special questions, address: Popular Science Institute, 250 Fourth Ave., New York, N. Y.

INSTITUTE BULLETINS *and* SERVICE AIDS FOR READERS

Insulation in Building Construction*
List of Approved Radio Products
What the Radio Buyer Should Know*
List of Approved Tools
List of Approved Oil Heating Devices
Advice on Installing Oil Heat
List of Approved Refrigerators
Refrigeration for the Home*

*Price 25 cents each

From dance hall floors to railway coach ceilings ..this grainless wood board

Beauty, such as paneled ceilings need, is usually required to sell a product. Durability, that a floor must have, is necessary to keep it sold. Manufacturers who adopt Masonite Presdwood find that it gives their products both durability and beauty. Samples for testing will be gladly supplied.

FOR DANCE HALL FLOORS

In a Denver dancing academy the tap-tap-a-tap of metal tipped clogs resounds from a floor of Masonite Presdwood. At Pullman, Illinois, ceilings of Presdwood are applied to railway coaches. And in scores of widely varying industries, hundreds of products are being made better and at lower cost because of this grainless wood.

Many of these Presdwood products require the strength and durability that are indicated in the service rendered at Denver. Used eight hours a day at the Fred Merritt School of Tap Dancing, the Presdwood floor showed no signs of wear, even after weeks and weeks of usage. Other Presdwood products may require smoothness and ease of finishing — there, again, Presdwood is ideal, as evidenced by its use for paneling . . . not only in ceilings of railway coaches but in fine homes and buildings as well.

Is easily cut

Beauty and lasting qualities are but a part of the advantages of Masonite Presdwood. It is moisture resisting and almost immune from warping, shrinking and buckling. It is extremely easy to work with. It can be sawed, punched, planed, milled or sanded. It is liked by shop foremen, experienced with materials of all kinds, and is just as welcome in homes where handy men put up shelving or build a radio cabinet. Wherever it is used it never harms fine tools, for it contains no artificial binder.

FOR RAILWAY COACH CEILING

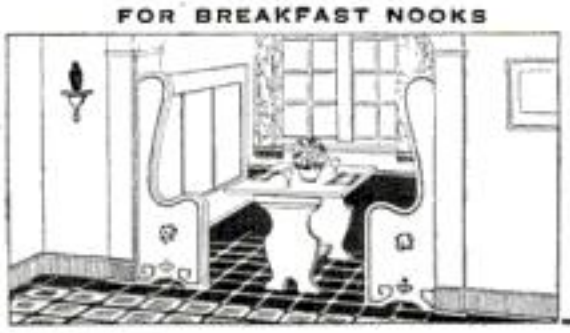
Has wide range of uses

The uses of Presdwood are many and varied. They range from bedroom screens to toys, from motor truck bodies to hydroplane hulls, from bread boxes to loud speaker tension boards, from out-door signs to kitchen cabinets, from office partitions to billiard tables, from clothes hampers to breakfast nooks.

Fully eighty of Presdwood's many uses, in industry and the home, are listed in the Presdwood booklet which is gladly sent to those who appreciate the beauties of fine materials or who wish to effect manufacturing economies with this workable grainless wood.

MASONITE CORPORATION
Dept. 728, 111 West Washington Street
Chicago, Illinois

FOR BREAKFAST NOOKS



Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION
REG. U.S. PAT. OFF.

FOR PANELING

Our Readers Say—

Calm Yourself, Mac

"A SPECTACLE indeed—POPULAR SCIENCE MONTHLY attempting to revive old John D. Rockefeller and make him over into a guardian angel of science! In one issue I read a rather convincing article on the Rockefeller Institute for Medical Research. But in the very next issue along comes an article on 'What John D. Rockefeller Has Done for Me,' picturing him as 'the greatest benefactor of science who ever lived.' What's the idea?

"I see where the Power Trust has been exposed buying control of American newspapers. Can it be that POPULAR SCIENCE has fallen for the glitter of some of John D.'s bright new dimes? Or what?

"The picture of Harry Sinclair soaking in jail while pious old John D. steps into the pages of POPULAR SCIENCE as 'a tremendous and vital force in the advance of science' is really too touching to contemplate.

"Oil seems to have a way of spreading itself in devious and wondrous ways."—S. MacL. Seattle, Wash.

What—More Bills?

"ONE good argument Mr. Eastman missed in advocating the proposed thirteen-month calendar is that we won't need to be bothered any more with those beautifully adorned calendars sent out each year by the coal man and the life insurance agent."—S. L. F., Springfield, Ill.

"Why didn't George Eastman mention the fact that there would then be thirteen rent bills, gas, electric, and installment bills, with but twenty-six pay days, as usual, per year?"—L. N. E., Racine, Wis.

See Page 21 for Answer to This Mystery

"IN ONE of your recent issues, John F. O'Ryan says that nonexplosive fuel will replace gasoline for aviation. Of what use is a fuel if it will not explode? The explosions in the motor are what make it go."—H. L. A., Pitcairn, Pa.

Maybe They're Dry Flies

"ONE of your recent articles contained the statement: 'Watch a fly which has been submerged in water. It cannot fly until it has dried off.' A few minutes ago I submerged two common house flies (nursa domestica) in water, releasing them six inches below the surface. Both rose to the surface of the water and immediately flew away. Many insects will do this—those with wings to which water does not adhere."—C. L. N., Raleigh, North Carolina.

Thanks—It'll Be Out Soon

"I WOULD like to know whether your most interesting series of articles, 'The Real Fathers of Flight,' will appear in book form. I have read every installment in POPULAR SCIENCE MONTHLY and enjoy it greatly. The illustrations and the story are so interesting that I should think that the book would sell to the general public. If you haven't considered this before I hope you will give it serious consideration now."—C. M., New York City.

Who Can Settle It?

"AN EDITORIAL in your July number implies without directly saying so that the wheel is the most important invention. I had thought that the question was settled years ago. The alphabet is the world's most important invention for reasons that are too obvious for me to state. Think it over."—B. L. M., New Haven, Conn.

This Is Certainly Tough

"I AM truly glad that Mr. R. L., Ph.D., of Bismarck, N. D., has joined the few who understand Einstein. But I wish he would tell me and the rest of your readers something. If this old world jumps up to meet us to keep us from falling and getting hurt when we step off of a tower or high steeple, or if it is going up our way, what is it doing to them poor Chinamen on the opposite side from us? The earth can't jump two ways at the same time, so if that poor Chinaman happens to step off of a high tower at the same time one of us does, that poor fellow is left out in space, and *where will he go?*"—F. C. C. C., Flint, Tex.

The Kind We Like to Get

"YOU may be interested to learn from an old reader of POPULAR SCIENCE MONTHLY that he considers the series of pencil sketches of inventors and engineers which you are now running one of the best things you have done in a long time.

"The ones of Edison, De Forest, and Hoover I have had framed for the walls of my study, and trust that there will be several more to follow which I can have framed in the same style and add to my collection.

"I would also like to add a word of praise for the artist, Mr. Rosenmeyer, who, it seems to me, has a wonderful ability to put on paper the spirit of his subjects. May he be able to give us many more drawings equal to the four or five that have appeared.

"As to the magazine in general, I can only say that it is the most interesting paper that I read. While I receive, and read more or less, many technical and scientific publications, I find POPULAR SCIENCE MONTHLY holds my attention from cover to cover, due to the human interest quality of its contents, which is entirely lacking in so much scientific literature."—L. S. M., Hartford, Conn.

"I have read your magazine since last November, and I think it one of the finest I ever read. I call it a 'Storehouse of Knowledge,' clean and wholesome in every sense of the word, and my wish to you is long may you grow and prosper."—J. A. H., Louisville, O.

His Favorite Authors

"PLEASE don't let Bunch and Koch, Edward Thatcher, or Captain McCann stop writing articles for POPULAR SCIENCE, as they have made the Home Workshop Department of the magazine second to none."—T. P. G., Charlotte, N. C.

"I am very much interested in your Home Workshop Department and have found some very good projects to make, for which I am grateful to you."—A. H., Milwaukee, Wis.

Answering O. T. K.

"O. T. K., of Poughkeepsie, N. Y., wonders why POPULAR SCIENCE prints such an 'insidiously harmful' set of articles as 'I Am Learning to Be a Flyer.' O. T. K. is certainly ignorant of airplanes and aviation. There is more study, work, and responsibility in aviation than any other occupation."—A. E. T., West Hartford, Conn.

"I can't help but feel that O. T. K. has at some time tried to pass the test for air pilot and was rejected."—J. F. C., Indianapolis, Ind.

"Of course, O. T. K. is right in some things. Aviation was not made in a minute, and it takes study and hard work to make a successful pilot."—G. R. M., Washington, Pa.

"The chief criticism of O. T. K. seems to be that you have pictured aviation as a career in too rosy hues. In my estimation that is impossible to do."—D. K. D., Helper, Utah.

"The comment of O. T. K. is well founded, although I do not agree with it entirely. I personally have found Larry Brent's articles very interesting, but they should not be permitted to become the factor in deciding one's life vocation."—J. C., Brooklyn, N. Y.

"O. T. K. is all wet."—W. R. McP., San Leandro, Calif.

Who Knows Another One?

"MR. KARL P. SCHMIDT states in his article on snake stories that snakes do not milk cows. Maybe Mr. Schmidt isn't fully acquainted with the habits of all of our Florida snakes. Unfortunately, we have a snake that is known as the gopher snake. It won't milk a cow every time it sees one, but will do it now and then.

"This snake is of a steel-blue color, grows to a length of eight feet, sometimes having a diameter of three and a half inches at the thickest part, is not poisonous, and puffs or blows at anyone who comes too close, like an old turkey hen. It is usually discovered in damp parts of the country. It feeds on rats.

"At one time my father had about fifteen cows. For two or three afternoons in succession one of them would come out of the pasture with no milk in her udder. We blamed the loss of milk on a neighbor. On a succeeding afternoon I watched the cows from behind brush and trees and caught a gopher snake, red-handed, getting his afternoon tea."—H. R. H., Jupiter, Fla.

Snubbed *into* solitaire

Here is a man of charm and distinction who loves bridge and plays it like a master. Yet were you to follow him to Palm Beach in the winter or to Newport in the summer, you would usually find him playing solitaire—certainly not from choice—but actually snubbed into it by those of his own set. He is the fourth nobody wants. And he doesn't know why.

If you have ever met a person with a real case of halitosis (bad breath) you can readily understand what a barrier to social or business success it would be. Imagine yourself in such a predicament.

As a matter of fact, the probabilities are that you *do* have halitosis *frequently*. Few escape it for the reason that every day, in normal mouths, odor-producing conditions (many of germ origin) develop. So, thousands have halitosis and are unable to detect it.

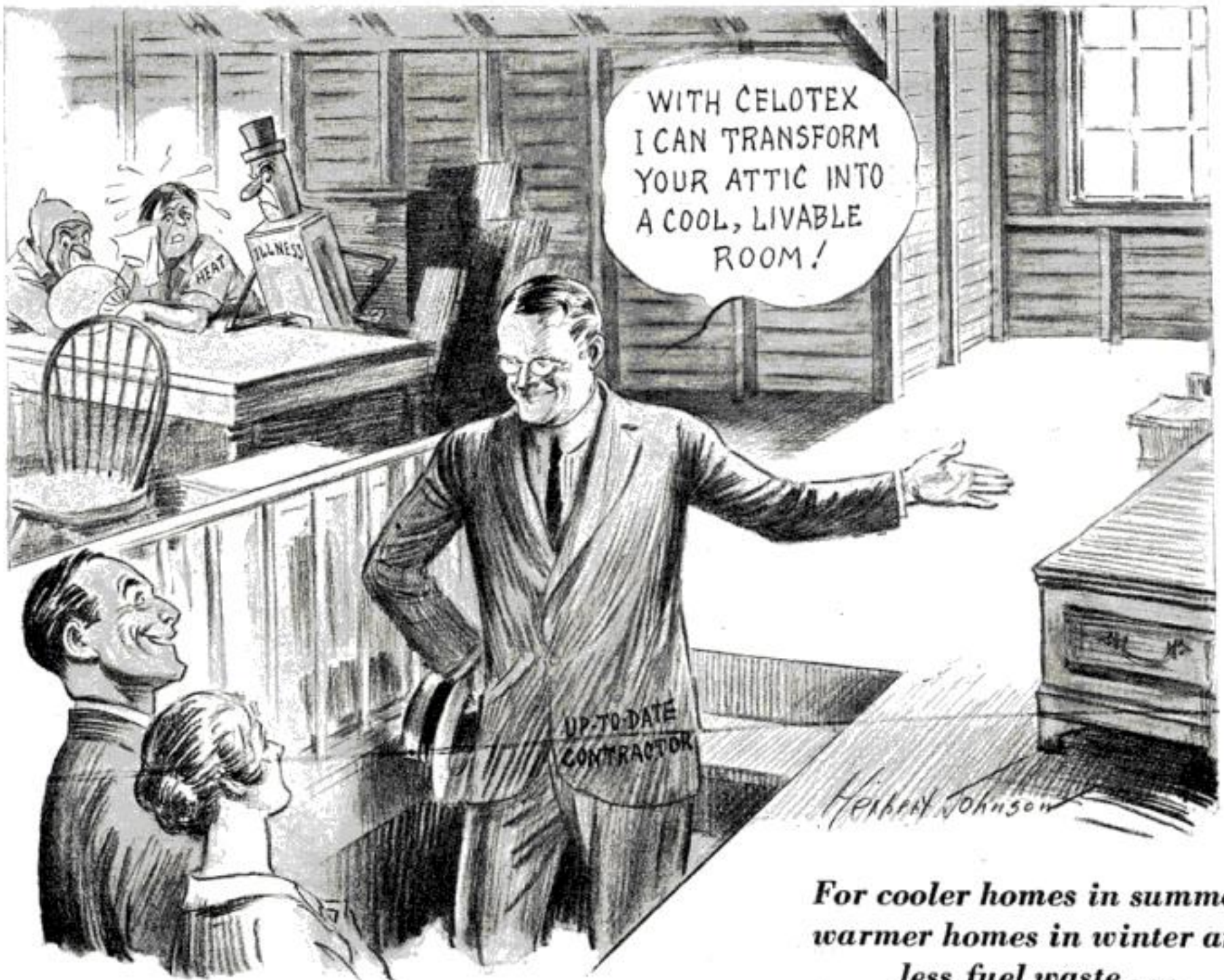
Since the risk is great and detection difficult, the wise thing to do is to definitely put your breath beyond suspicion by the daily use of full strength Listerine as a mouth wash and gargle. It both prevents halitosis and ends it, should it get the upper hand.

While safe and pleasant in action, full strength Listerine is a powerful germicide which kills even the stubborn Staphylococcus Aureus (pus) germ in 15 seconds. Naturally, it destroys lesser germs in the mouth. Furthermore, it's an active deodorant which overcomes odors of all kinds.

No fastidious person will omit the use of Listerine daily. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

LISTERINE

THE SAFE ANTISEPTIC



For cooler homes in summer, warmer homes in winter and less fuel waste . . .

Insulate at the roofline . . .

MODERN home owners insist on *Celotex* for repair and remodel work because it *insulates* as well as builds . . . keeps your home at an even temperature through all seasons and changes in weather.

Celotex insulated roofs *resist* the passage of scorching sun's rays . . . *retard* furnace-heat-leakage . . . help keep out penetrating dampness and chill.

With the roof insulated with Celotex, you can use the attic for extra living space, for bedrooms, playroom, workshop or den. Attic rooms protected by Celotex are always cozy and healthful.

Celotex is the *only* insulation made from the long, tough fibres of cane. It comes in big, strong boards, 4 feet wide, 7 to 12 feet long and 7/16 of an inch thick. Also made "double-thick"—7/8 inch.

When used on the outside of houses, as sheathing, Celotex adds structural strength . . . makes walls tighter and more permanent.

And on inside walls and ceilings, you can obtain finer, smoother plastered surfaces with Celotex Lath. This new lath, 18 inches by 48 inches and 7/16 of an inch thick (also made "double-thick"—7/8 inch), is especially designed to reinforce against plaster cracks and to eliminate disfiguring lath marks.

Be sure it's *Cane Fibre* Insulation!

Only Celotex is made from the long, tough fibres of cane. The peculiar advantages of cane fibre insulation cannot be obtained in any other material. Be sure you get CELOTEX!

Ask your architect, builder or dealer for further information on Celotex—and write to us for our free booklet, "Year 'Round Comfort and Fuel Saving for Every Home."

The Celotex Company, Chicago, Illinois. In Canada: Alexander Murray & Co., Ltd., Montreal. Sales distributors throughout the world. All reliable dealers can supply Celotex Standard Building Board and Celotex Lath.

The word CELOTEX (Reg. U. S. Pat. Off.) is the trademark of and indicates manufacture by The Celotex Company Chicago, Illinois

CELOTEX BRAND
INSULATING CANE BOARD

When you buy a new house, look for the Celotex sign. It is your assurance of greater home comfort

Popular Science MONTHLY

AUGUST, 1929 SUMNER BLOSSOM *Editor* VOL. 115, NO. 2

Taught Himself *to* Fly *and* Broke *a* World's Record

A Dramatic Story of an Eight-Day Spectacle—How a Junk Plane Was Kept in the Air More Than a Week

By MICHEL MOK

"Reg" Robbins (left) and "Jim" Kelly, with Mrs. Robbins and Mrs. Kelly, after record duration flight in the *Fort Worth*, above.

AN OLD but graceful single-motored Ryan brougham monoplane swooped down to a perfect "three-point" landing at the Meacham municipal airport at Fort Worth, Tex., one Sunday afternoon a few weeks ago. Cheering wildly, 60,000 men and women who had been waiting to see it touch the earth broke through ropes and a cordon of police, overran the muddy field, and engulfed the little silver sky-ship.

Deadly tired, covered with grime, but grinning behind eight days' growth of beard, two young men clambered stiffly out of the cabin and were almost crushed by their excited fellow citizens.

One of them, James Kelly, just twenty-three years old, was an ex-cowboy with little flying experience. The other, Reginald L. Robbins, three years his senior, was a former railroad mechanic who had never had a flying lesson in his life.

These two semiamateurs had finished the longest sustained flight ever accomplished. With only each other for company, they had flown night and day for 172 hours, thirty-two minutes, and one second—four and a half hours more than a week! They had shattered the refueling endurance record established a few months previously by the *Question Mark*, the three-motored, $100,000 U. S. Army plane, manned by five experts and backed by the Government's mechanical and scientific resources, by twenty-one hours, fifty-one minutes, and forty-six seconds—nearly a full day!

And they had achieved that amazing feat in a reconditioned airplane, christened the *Fort Worth*, that already had flown a total of 50,000 miles—equal to twice the circumference of the earth—and that was equipped with a Wright Whirlwind motor which had been bought secondhand two years previously and had run for 500 hours since. Moreover, they had never refueled a plane until their flight was actually under way, and had practiced the making of contact, without transfer of gas, only three times on the day before taking off.

Not only had they staged a dramatic eight-day spectacle, but by demonstrating the endurance and airworthiness of a single-motored ship and the feasibility of refueling over a long period, they had made a definite contribution to the progress of aviation.

BRILLIANT as it was, their accomplishment did not stand alone. It was the most spectacular of an astonishing series of aerial feats, which followed in quick succession. Within three days from the descent of the *Fort Worth*, a new altitude mark was hung up by a German flyer who climbed almost eight miles, a new speed mark was set by two French army pilots, and the United States witnessed a new solo endurance record, a new altitude record for light planes, a new seaplane speed record, and a new altitude record for women!

When the *Fort Worth* landed, Kelly and Robbins scarcely had time to stretch their legs after climbing out of the cramped quarters in which they had traveled 12,900 miles before they were bombarded with questions.

"How do you feel?" Robbins was asked. The chief pilot of the monoplane was slightly deaf from the constant droning of his faithful motor, and the question had to be repeated.

"Oh!" he said, rubbing his chin. "Right now I feel like having a shave!"

"WHAT was the hardest part of the flight?" someone asked Kelly.

The former cowpuncher chuckled.

"Keeping 'Reg' (Robbins) awake long enough to pilot the ship," he replied in his Texas drawl, "so I could snatch a little sleep!"

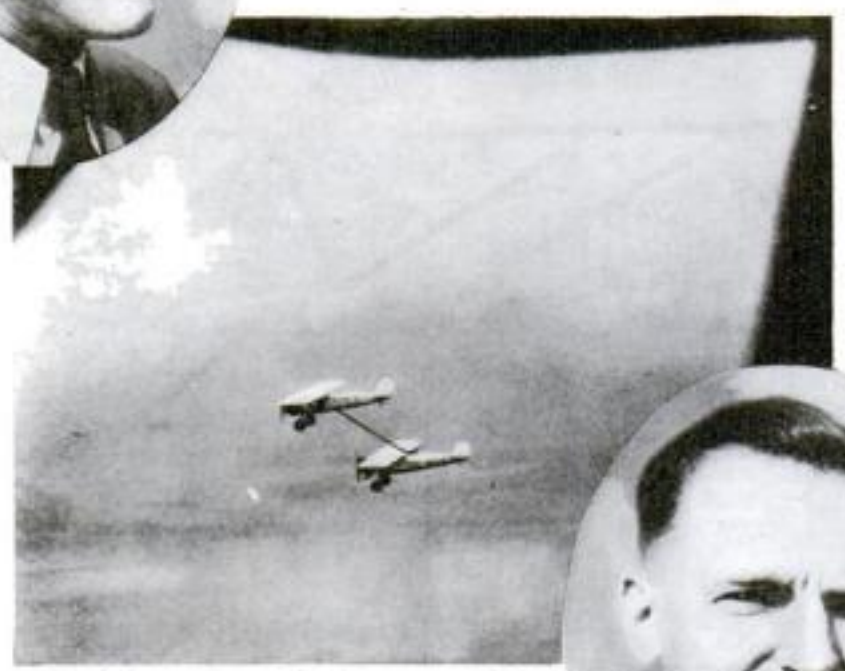
These answers epitomized the characters and dispositions of the unassuming men who had given an exhibition of courage and cool-headed skill rare even among airmen. Twice, at least, death had grazed the wings of their rebuilt plane as they were wheeling about endlessly half a mile or more above the airport, but it had failed to break their dogged determination to finish history's longest excursion in the air. And through danger, discomfort, and sickness, their sense of humor did not desert them for a moment.

That same "Jim" Kelly, riding the plane like an aerial broncho buster on the second day of the marathon, came within an inch of being cut to ribbons or hurled to the ground from a height of some 2,500 feet! Perched on an eight-inch catwalk along which he had to crawl twice each day to grease the rocker arms of the engine, the buckle of his safety belt nicked the propeller. One glancing blow from the blade, whirling 1,300 revolutions a minute, and the cowboy never would have made another flight, uttered another joke, nor seen the girl he had married just six weeks before!

IN A note dropped by Robbins that day, not a word was said about Kelly's narrow escape from death. The chief pilot, in his message, merely complained of a slight attack of air-sickness. Nor did it become known until after the pair were safely back to earth that it was this same mishap to the propeller that finally forced the *Fort Worth* down to earth.

The tiny crack in the wooden blade began to widen during a heavy rain the flyers encountered on the Friday night before their descent, resulting in an ominous vibration. At the same time, they saw that the fabric of the wings was beginning to fray under the impact of wind and rain following the steady grind of continuous flying. But by the following evening the endurance record of the *Question Mark* would be topped by the one required hour. Robbins and Kelly set their jaws, and kept on.

They made it! That Saturday night, with victory theirs, you might have thought they would have "called it a week" and glided down to safety. But they did nothing of the sort. They were determined to remain in the air 200 and, if possible, 300 hours! "We plan to stay up until she falls apart," Robbins, the self-taught flyer, had said when they took off in their secondhand plane. He kept his word.



One of seventeen refueling contacts during the *Fort Worth's* flight. Above is K. K. Hoffman, pilot of the refueling plane *Midland*. At right: H. S. Jones, who handled job of lowering gas hose.

At midnight, the *Fort Worth* ran into a severe electrical storm. Kelly was at the controls when it broke. A terrific crash of thunder awoke Robbins, who had been asleep for about an hour. He took the controls. Drenching rain, mixed with heavy hailstones, beat upon the frazzling wing fabric. The gash in the propeller was widening constantly. This they knew because the motor vibration increased by the minute. Dazzling streaks of lightning shot from black clouds. Then a blinding flash! The pilots looked into each other's faces.

"Are we struck?" asked Kelly.

"Almost," said Robbins.

Through a forty-mile gale, through rain and hail, amid deafening peals of thunder, the former railroad mechanic piloted the *Fort Worth* to safety.

ONCE out of the storm, he "hugged" Meacham Field for the rest of the night. When daylight came on Sunday morning, the flyers decided to try keeping the plane aloft until 11:33, when an entire week would have elapsed since they hopped off. Again, they made it! But still, they were not satisfied. It then occurred to them to stay up until afternoon to give as many of their fellow citizens as possible a chance to see the *Fort Worth* land. Running the risk of crashing with a shattered propeller, they kept on winging until 4:05 P.M. Robbins had made good his promise. Had they remained in the air longer, the propeller undoubtedly would have flown to bits and the plane literally would have "fallen apart"!

When the flight began Robbins, who had never attended a flying school, had had about six years of experience as a commercial flyer and a "barnstormer." With his savings, he had bought the old Ryan monoplane, the despair of everybody except himself. He consented to have the ship rebuilt but refused to have the motor touched. "I can coax it better if it's left the way it is," he said.

KELLY, who had been a cowpuncher since he was a lad, had the advantage of formal flying instruction, but he was a greenhorn at the game. He had finished his course less than two months before he stepped into the cabin of the *Fort Worth!*

With 250 gallons of gasoline aboard, the secondhand Ryan took to the air at 11:33 on a Sunday morning. Except for Kelly's "close call" on Monday morning, and Robbins' attack of air-sickness, all went well during the first five days. Refueling took place regularly three times a day, except on one day when the reserve supply of gasoline was so large that once was enough. In all, seventeen refueling contacts were made successfully. The last, early on the final Sunday morning of the flight, was accomplished in a driving rain. This is believed to have been the first time that a plane, in mid-air, has ever been refueled in a rainstorm.

AN INNOVATION in refueling was introduced by Robbins. The pipe into which the refueling hose was to fit was connected at the side of the *Fort Worth* instead of

The crowd rushing out to meet the *Fort Worth* as it landed at Meacham municipal airport, Fort Worth, Tex., at the end of the record flight of more than a week in the air.

being placed in the top, as was the case on the *Question Mark*. This was done to reduce the danger of fire or asphyxiation through spilling of gasoline over the ship.

This is how the delicate and dangerous refueling maneuvers were executed:

THE *Midland*, the refueling plane, also a Ryan brougham, piloted by K. K. Hoffman and carrying H. S. Jones as "contact man," went up early each morning and again twice in the evening to supply the *Fort Worth's* needs. While the refueling ship hovered over the endurance plane, Jones dropped a thirty-seven-foot hose through a hole in the bottom of the *Midland*. Meanwhile, Robbins pulled his ship under the supply plane in such a way that the funnel, situated back of the right wing of the *Fort Worth*, would maintain a position some twenty feet under the hole in the *Midland*. Kelly then caught the end of the hose and inserted it in the funnel. While the gas was turned on from the upper ship, Robbins flew with one hand on the "stick" and the other on the throttle. When the tank was full, he pulled to the left and dropped away.

Although a distance of twenty feet between the two planes was the rule, only ten feet of the hose was used on a few occasions! Sixteen of the seventeen contacts made during the flight were accomplished without a hitch. Once, fifteen gallons of gasoline were spilled when Kelly forgot to remove a rag used to keep dust from the funnel. The contacts, which occurred at an altitude of from 2,500 to 4,000 feet, took eight minutes each. About 110 gallons of gasoline were transferred in the mornings and from 130 to 140 gallons more in the two refuelings at night. Twice daily, four and a half gallons of oil were taken on by the *Fort Worth*.

FOOD, sacks of mail, and newspapers also were lowered to Robbins and Kelly at regular intervals. Thus, living for more than a week from half to two miles above civilization, they enjoyed the novel experience of reading descriptions of the progress of their feat in their home-town papers from day to day!

Even a touch of family life was introduced into this picturesque adventure. On Wednesday when, with seventy-six hours of flying to their credit, the pilots had passed the minimum halfway mark, Mrs. Robbins and Mrs. Kelly celebrated the occasion by "visiting" their husbands! The airplane in which they went up played about the *Fort Worth* for about half an hour, while the two couples had a good "plane-to-plane" talk by means of signals.

Mrs. Robbins and Mrs. Kelly virtually lived on Meacham Field during the week of the flight. Here they were kept in constant touch with the flyers through notes dropped by Robbins.

The pilots went aloft without parachutes, but after Kelly's near-mishap they asked for them. They received them on the third day, when Robbins dropped a note which said:

"I am afraid the end is near! Kelly has a 'chute now and is thinking of his wife. I can't refuel alone!

In another note, referring to the cramped three-by-three-foot space in which they slept, he said:

"We can understand how people who live in small houses get by." That was on Friday. After that came the storm, and Robbins, though he kept his nerve, had other things to think about than the dropping of jocular messages.

Three record makers. Marvel Crosson, girl flyer of San Diego, Calif., who set an unofficial women's altitude record of 24,000 feet. Top: Barney Zimmerly, who climbed 24,600 feet to break world's altitude record for light planes. Left: Herbert J. Fahy, a test-pilot, who stayed up nearly thirty-seven hours for a new solo endurance mark.

MORE than likely, both he and Kelly were heartened for their fight with the elements by a great ovation they received on Friday evening, when they had exceeded the *Question Mark's* record by the necessary hour. Thousands of their friends and well-wishers at the airport staged a celebration in which the entire city joined. The *Fort Worth* swooped to within 100 feet of the crowd and the pilots waved their thanks to the throng who cheered and waved in reply.

Similar scenes were again enacted on the Sunday afternoon of their descent. Then the flyers received, in addition to cheers, a fund, raised by the Fort Worth Association of Commerce, which had passed $12,000 by the time they landed. They received also nearly $2,200 from six air transport companies which jointly offered them $100 for each hour they would stay aloft after breaking the *Question Mark's* record.

THEIR splendid achievement immediately seemed to serve as an incentive for a number of other fine aerial feats. Three days after the landing of the *Fort Worth*, Herbert J. Fahy, test-pilot for the Lockheed Aircraft Company, of Los Angeles, Calif., broke all records for solo endurance flights, staying aloft thirty-six hours, fifty-six minutes, and thirty-six seconds. Fahy not only shattered the official record of thirty-four hours and fifty-three minutes established by Royal Thomas, but also the unofficial mark of thirty-five hours, thirty-three minutes, and twenty-one seconds hung up by Martin Jensen.

The previous day, Barney Zimmerly, of Marshall, Mo., had established a new world's altitude record for light airplanes by ascending to a height of 24,600 feet above Park Airport, East St. Louis, Mo., in a 690-pound low-wing Barling NB-3 monoplane.

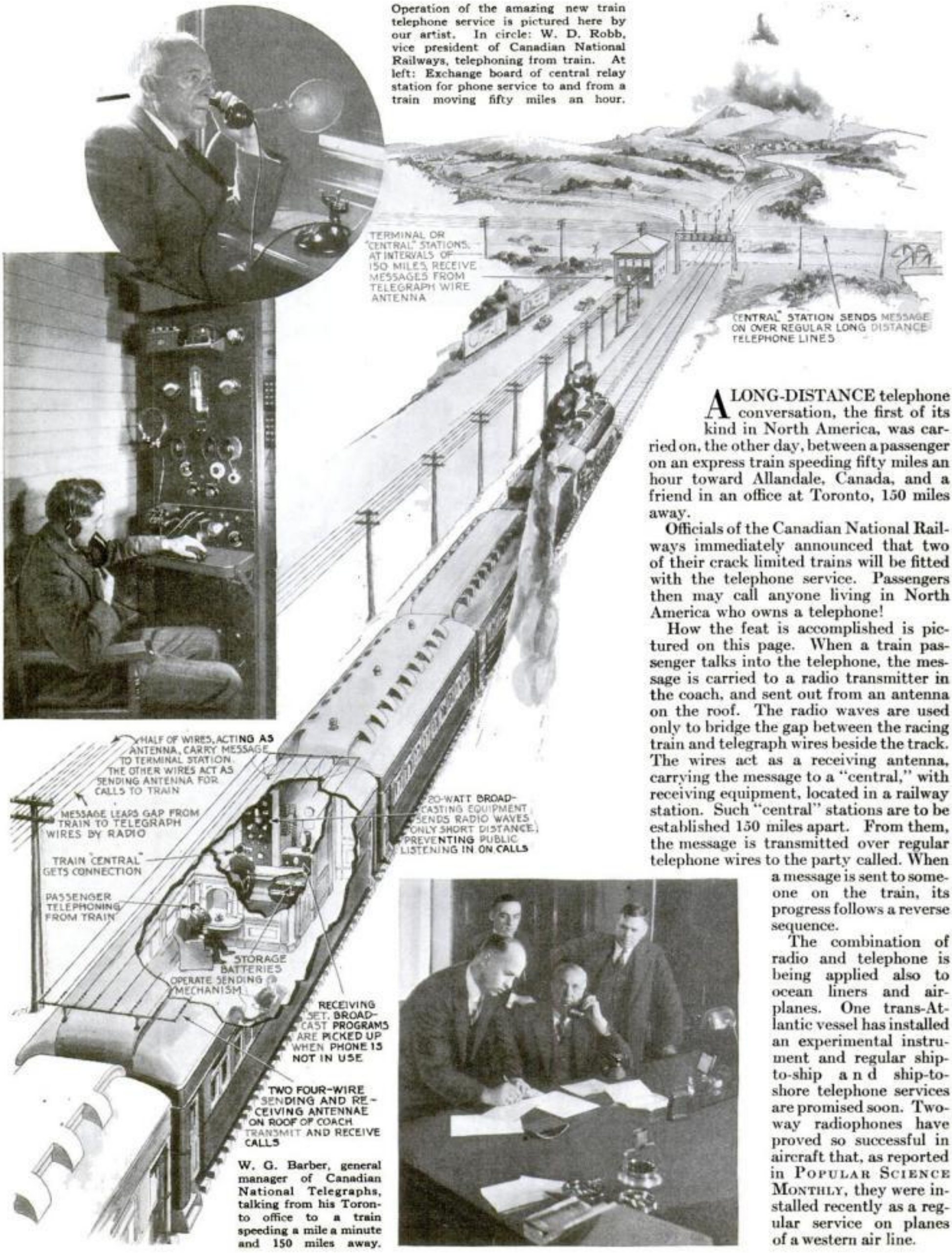
CLIMBING in a cabin monoplane until the altimeter indicated a height of 24,000 feet, Miss Marvel Crosson, of San Diego, Calif., set an unofficial altitude record for women the same day. The previous mark, made by Mrs. Louis McPhetridge Thaden, of Oakland, Calif., was 20,270 feet.

A day or two before the victories of Zimmerly and Miss Crosson, all existing speed records for military seaplanes were smashed by Lieut. W. G. Tomlinson, of the Navy, who covered the 100-mile course over the Potomac River at an average speed of 175.01 miles an hour in the tenth Curtiss Marine Trophy Race.

In France, about the same time, Commandants Weiss and Girier, French army pilots, broke the world's speed record for a distance of 5,000 kilometers (about 3,125 miles), flying their 600-horsepower army plane twenty-six hours at an average speed of 180 kilometers (about 112 miles) an hour.

Finally, at Dessau, Germany, Willy Neunhofer reached an altitude of 41,795 feet, nearly eight miles above the earth, exceeding the recently-set world's record of Apollo Soucek, U. S. Navy pilot, by 2,655 feet.

Now—Phone Home from a Train!



Operation of the amazing new train telephone service is pictured here by our artist. In circle: W. D. Robb, vice president of Canadian National Railways, telephoning from train. At left: Exchange board of central relay station for phone service to and from a train moving fifty miles an hour.

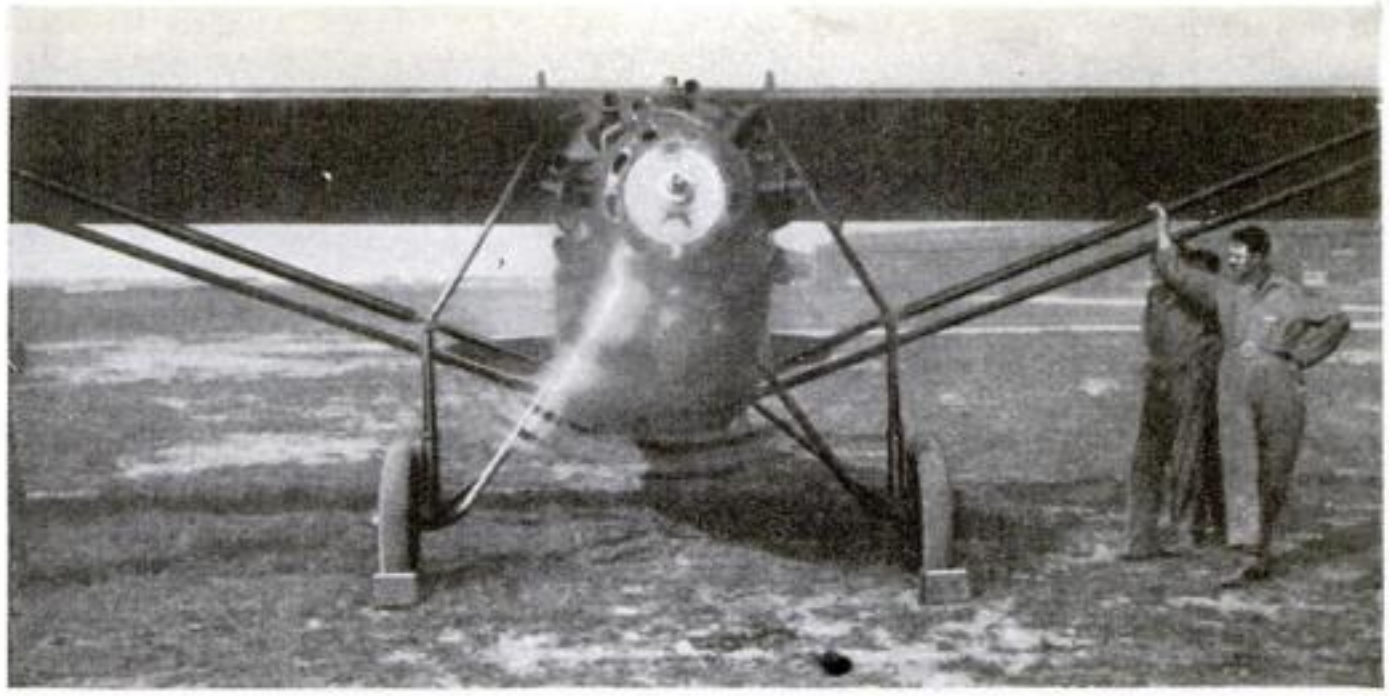
W. G. Barber, general manager of Canadian National Telegraphs, talking from his Toronto office to a train speeding a mile a minute and 150 miles away.

A LONG-DISTANCE telephone conversation, the first of its kind in North America, was carried on, the other day, between a passenger on an express train speeding fifty miles an hour toward Allandale, Canada, and a friend in an office at Toronto, 150 miles away.

Officials of the Canadian National Railways immediately announced that two of their crack limited trains will be fitted with the telephone service. Passengers then may call anyone living in North America who owns a telephone!

How the feat is accomplished is pictured on this page. When a train passenger talks into the telephone, the message is carried to a radio transmitter in the coach, and sent out from an antenna on the roof. The radio waves are used only to bridge the gap between the racing train and telegraph wires beside the track. The wires act as a receiving antenna, carrying the message to a "central," with receiving equipment, located in a railway station. Such "central" stations are to be established 150 miles apart. From them, the message is transmitted over regular telephone wires to the party called. When a message is sent to someone on the train, its progress follows a reverse sequence.

The combination of radio and telephone is being applied also to ocean liners and airplanes. One trans-Atlantic vessel has installed an experimental instrument and regular ship-to-ship and ship-to-shore telephone services are promised soon. Two-way radiophones have proved so successful in aircraft that, as reported in POPULAR SCIENCE MONTHLY, they were installed recently as a regular service on planes of a western air line.



Warming up the Diesel motor of the oil-burning "mystery plane" for its first public demonstration at Langley Field, Va.

650 Miles *by Plane for* $4.68!

Startling New Facts About the Oil-Burning Diesel Motor That Promises Sweeping Changes in Aviation

By ROBERT E. MARTIN

TWO men recently slid down from the sky and landed their plane on Langley Field, Virginia. They had come to attend the Fourth Annual Engineering Research Conference held under the auspices of the National Advisory Committee for Aeronautics. No one noticed them particularly—the arrival or departure of an airplane at an aviation field is a commonplace occurrence. But as soon as the plane was safely on the ground, things began to happen. Huge special tarpaulins were swished out of the fuselage and the motor was wrapped up like a mummy. Then heavy chains were drawn around the tarpaulins and secured by padlocks.

The men were Capt. L. M. Woolson, of the engineering staff of the Packard Motor Company, and his assistant, Walter Lees. They had just completed an epoch-making flight in a plane powered by a secretly-designed new motor that may revolutionize aviation.

WHILE Captain Woolson still is uncommunicative about the details of the "mystery motor," which he designed, he disclosed one important fact: The airplane had traveled from Detroit to Langley Field, a distance of 650 miles against adverse weather conditions, without halt or trouble of any kind, and at a fuel cost of only $4.68. A similar airplane, powered by the ordinary gasoline aviation motor, would have used more than twenty-seven dollars worth of fuel on such a trip!

Captain Woolson at last was persuaded to stage a demonstration. Experts were not permitted to make a detailed examination of the motor, which in outward appearance so closely resembles the standard gasoline airplane motor that the average man could not tell the difference. However, the fact that the motor

Capt. L. M. Woolson, Packard motor engineer, designer of the new Diesel type airplane engine.

burns fuel oil instead of gasoline, coupled with such details as could be seen, makes it possible to give a general description of the motor and to some extent forecast its possibilities.

The new motor is of the Diesel type. Its use of fuel oil instead of gasoline eliminates one of the most serious hazards of airplane operation—the ever-present possibility of fire. It has nine cylinders set like the spokes of a wheel. The familiar spark plugs and carburetor which form an indispensable part of the ordinary gasoline aviation engine are absent. There is only one valve in each cylinder head. The engine is of the four-stroke type and operates at from 1,700 to 2,000 revolutions per minute, about the speed of ordinary gasoline aviation motors. It is said to weigh about three pounds for each horsepower developed, as compared with an average two-pound weight for each horsepower of the gasoline type motor—a disadvantage which is more than offset by reduction in weight of fuel, as will be shown later.

THE forerunner of Captain Woolson's creation is the heavy, lumbering Diesel engine built only in large sizes for industrial plants and motor ships. Curiously enough, mystery surrounds Dr. Rudolf Diesel, the German engineer physicist who invented the engine which bears his name. He disappeared from a cross-channel steamer while on his way to England just before the outbreak of the World War.

The operation of the Diesel-type engine is simple in principle. In the four-stroke gasoline motor used for airplanes, motor boats, automobiles, and so on, the piston on its down stroke draws a charge of gasoline mixed with air in through the carburetor. On the next up stroke the charge is compressed, and at the top of the stroke an electric spark ignites the mixture and the piston is driven down for the power stroke. On the next up stroke the exhaust gases are expelled through the exhaust valve and the cycle is repeated.

The four-stroke Diesel motor operates in much the same way except that when

the piston goes down, instead of drawing in a charge of gasoline and air, it draws in a charge of plain air. When it comes up again it compresses the air to a pressure of about 500 pounds per square inch, compared with the ninety pounds of compression in the average gasoline motor. At the top of the stroke a small quantity of liquid fuel oil is squirted directly into the highly compressed charge of air and, since compressing air to 500 pounds produces a temperature of about 1,000 degrees F., the fuel immediately ignites and drives down the piston. The following up stroke, of course, drives out the exhaust gases through the exhaust valve.

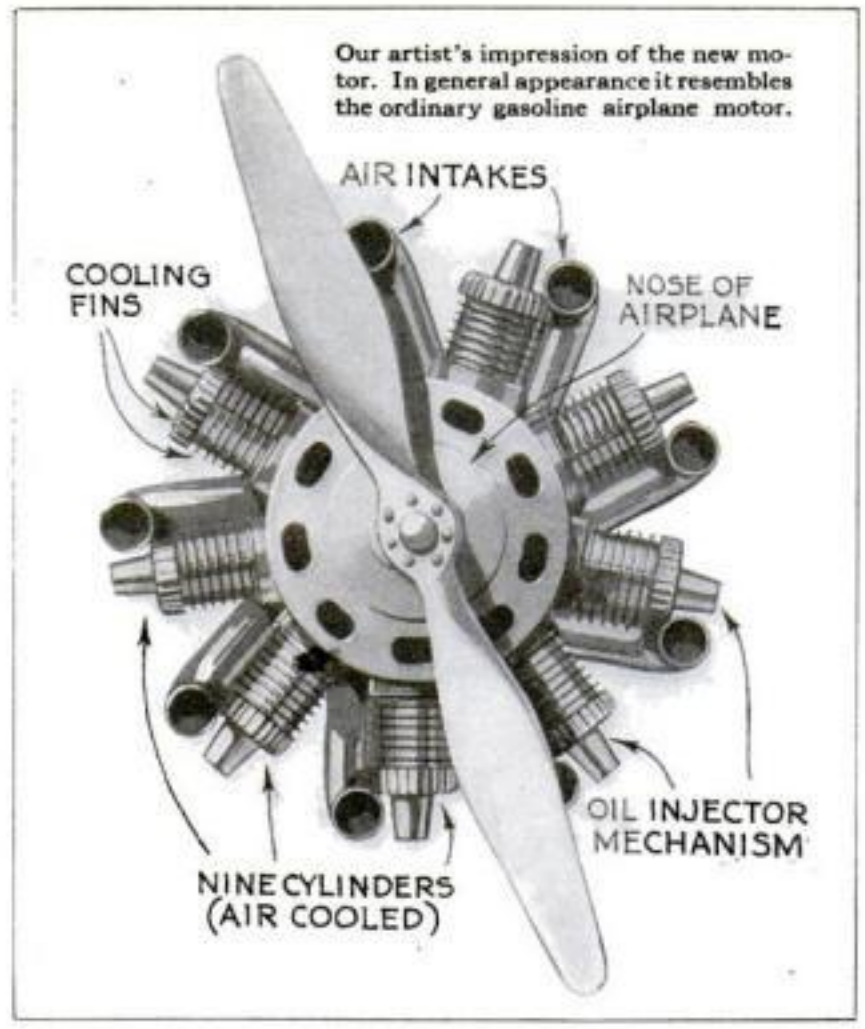
THE common gasoline motor has two valves, one to let in the charge of gasoline and air, the other to let out the exhaust gases. The Diesel marine engine also has two valves for each cylinder. Captain Woolson's motor, on the other hand, has but one valve for each cylinder. Consequently, this valve performs both the functions of letting in the charge of air and letting out the exhaust gases. The valve opens at the bottom of the stroke in the usual manner and remains open practically for a complete revolution of the flywheel while the piston is coming up to drive out the exhaust gases and going down again to draw in the fresh charge of air.

This construction is possible in the Diesel type airplane motor because of the short exhaust pipe and the absence of a muffler. The one-valve arrangement would be impossible in a marine type motor because of its long exhaust pipe and muffler.

The common method of starting the smaller sizes of Diesel marine engines is by compressed air, which is fed to the proper cylinder by means of a rotary valve. Captain Woolson starts his motor by the pressure of a button on the control panel in the cabin, and as several of the witnesses of the demonstration noticed a smell like gunpowder as the motor was started, it is quite possible that he uses the ordinary compressed air system in starting, rearranged to operate by the explosions of charges of gunpowder.

The possibilities of the new Diesel aviation engine are tremendous. The record shows that Captain Woolson used but fifty-four gallons of fuel oil traveling from Detroit to Langley Field. A similar gasoline-powered plane would have used ninety-one gallons of gasoline. While fuel oil weighs slightly more per gallon than gasoline, there is a notable saving in the weight of fuel required to drive the plane for a given distance. This means that a Diesel-powered airplane, in addition to costing far less per mile for fuel, should be able to carry enough of it to go many more miles than a gasoline-powered plane.

It is not too much to expect that new nonstop distance flights will be recorded and records may even be set that may never be equaled by gasoline-driven planes.



Our artist's impression of the new motor. In general appearance it resembles the ordinary gasoline airplane motor.

Reliability is quite obviously the first and most important feature of an aviation motor, and in this respect the new Diesel aircraft motor, is in a class by itself. There being no electrical ignition system, the usual troubles with short-circuited spark plugs, burned-out magnetos, burned timer contacts, and so on, are eliminated. In addition, the absence of electrical apparatus on the motor greatly simplifies the use of radio transmitting and receiving apparatus in the airplane.

OF COURSE, the Diesel aircraft motor can be disabled by a failure in the oil supply, and in this respect it is no improvement over the usual type of gasoline-driven motor.

Valve trouble should be cut in two on the Diesel aircraft motor because it uses just half the number of valves employed on a gasoline motor. Carburetor troubles, too, are eliminated, because there is no carburetor. The flow of fuel oil into each cylinder is controlled by a separate pumping arrangement so that the failure of the fuel supply on any one cylinder would not affect the operation of the other cylinders. Ignition, of course, cannot fail. So long as the pistons compress the charge of air to 500 pounds the temperature of the compressed charge will inevitably rise to 1,000 degrees F., and this temperature is considerably hotter than what we ordinarily term "red-hot."

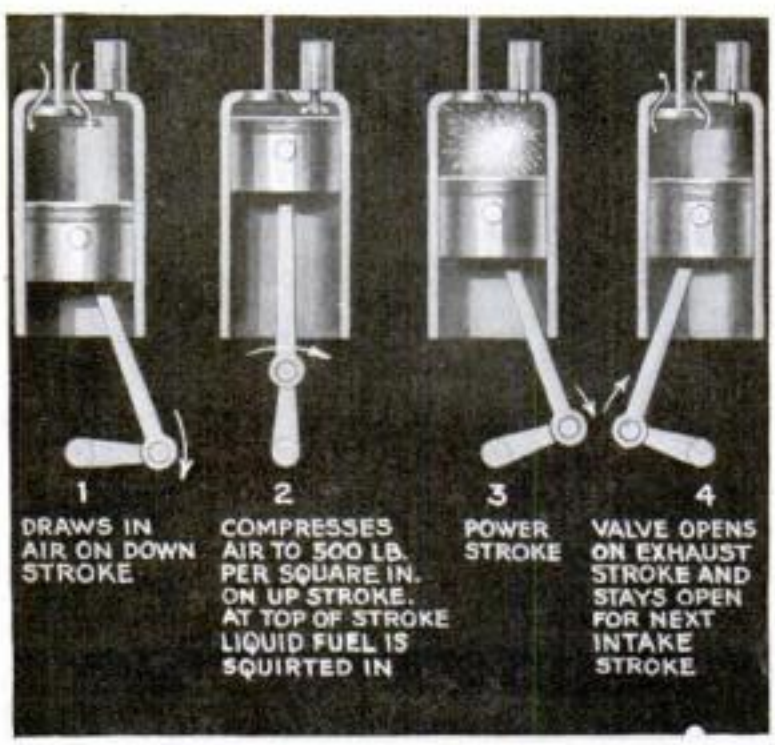
Will Captain Woolson's engine have any effect on the development of the automobile? Forecasting future developments is a rather uncertain business, but it must be apparent that the new engine ought to find its place in buses and trucks if not in ordinary autos.

AN AVIATION engine is operated at or near full power practically all of the time, and the Diesel type engine is inherently suited to such operation. Unless, though, Captain Woolson's motor has features that do not appear on the surface, it would not be ideally adapted to the operation of an ordinary automobile, the speed of which must constantly be changed to meet traffic and other conditions. In buses and trucks of the electric drive type, however, the motor is connected directly to an electric generator so that constant speed can be maintained.

The Diesel engine already has won its spurs in the higher horsepower units adapted to marine and stationary use and consequently Captain Woolson's development of the Diesel aviation engine will have little effect in this direction.

One other point must be considered. The production of any large number of airplane engines designed to use fuel oil in place of gasoline undoubtedly would result in an increase in the price of fuel oil and perhaps a decrease in the price of gasoline, so that the advantage of low cost of operation for the Diesel motor would tend to disappear as larger and larger numbers of them went into use.

But even if the price of fuel oil should be boosted, the Diesel airplane engine still would have a great advantage over its gasoline-operated competitor. Leaking pipes or even the worst crash landing cannot result in a fire, for fuel oil cannot be ignited by a spark as can gasoline. It will ignite only under the extreme temperature in the cylinder at the top of compression stroke.



The four strokes of the Diesel motor. Its compression is more than five times that of the gasoline airplane engine.

IT MAY truthfully be said that the introduction of the Diesel engine eliminates fire risk in airplane operation. A dirigible filled with helium gas and operated by Diesel motors likewise would be immune to fire. As this is written, reports from Germany state that Prof. Hugo Junkers, famous aeronautical engineer, is now experimenting with a Diesel engine powered plane. His experiments also are veiled in secrecy. It is apparent, therefore, that there is going to be competition in the development of the Diesel aircraft motor. It is a rich prize for which the engineers are competing—but America seems to be in the lead so far!

Tubes to Link City and Airport

Harvey Wiley Corbett (left) inspecting pneumatic mail carrier in N. Y. Post Office.

Our artist's conception of future high-speed subway and pneumatic tube systems for rushing passengers and mail between city terminal and airport, as predicted by Mr. Corbett.

Drawn Especially for POPULAR SCIENCE MONTHLY *by B. G. Seielstad*

FUTURE high-speed passenger and mail connections between congested cities and their suburban airports, as recently predicted by Harvey Wiley Corbett, noted American architect, are pictured here by our artist. Air mail, packed in bulletlike containers, he says, will be shot by compressed air through underground tubes running between the airport and a centrally located city terminal. Incoming and outgoing air line passengers will be whisked through a superspeed subway in streamlined cars.

The air terminal in the city will be much like that of a railway in its accommodations. Here passengers will consult information clerks, buy tickets, and descend to waiting subway cars, each of which will hold the same number of people as the cabin of an air liner. Arriving at the airport, they will step out and enter the waiting plane, already tuned up on its concrete embarking platform.

In the post office section of the terminal, and also at the airport, air compressors will supply mighty blasts to drive the letter containers to and from the air field. Incoming mail already will have been sorted into the containers in the air by a clerk aboard the plane.

A successful experiment in handling mail by "underground air guns" has been made in New York City. There twenty-five stations are connected by speedy pneumatic tubes said to transport letters a distance equal to five and a half times around the earth every day.

"There we were, on the wind swept shore, jawing at each other for all we were worth."

Crushed in the Jaws of Arctic Ice

Famous Old Sea Dog Who Won Glory with Peary Spins a Brisk Yarn of Adventure

By CAPT. ROBERT A. BARTLETT

As Told to FITZHUGH GREEN

A FEW years ago I braced myself abaft the wheel against a howling northeast gale, with black darkness of midnight around me, and watched my poor ship, the steam sealer *Leopard*, fight a losing battle for her life.

There was little we could do to save her. High seas were sweeping us toward the wild chaos of trash ice that lines the outer Newfoundland coast in early spring. Bitter cold numbed our hands. Our hull had sprung a dozen leaks. Our engine was sobbing its heart out over the impossible task of holding the ship against the tempest.

"Maybe we could get a fore staysail on her!" the mate yelled into my ear.

"Try it!" I yelled back.

They hadn't a ghost of a show. But it would keep their minds off death.

For an hour the men struggled waist deep in foaming seas. Frozen canvas tore the skin from their knuckles. One man's arm was nearly torn from its socket. Twice the sail started up and was snatched away by the wind. Finally it was torn to ribbons, flapping into the night like the shredded garments of a scarecrow.

The ship suddenly began to vibrate. It was as if a giant were underneath, pounding her hull with a huge mallet. Roar of the wind and sea was too great for us to hear anything. But we could feel it: *thump*—ker-plunk! Quiver—*crash!*

It was the ice; great jagged floes raftered by the wind and tossed about by the sea. First we would lift and slam down on one; then another would lift and slam down on us.

The chief engineer came crawling to me over the wet deck. "She's taking more water!" he sang out. "More than we can handle!"

I told him to give his blamed pumps more steam. He got mad and left. But there was nothing we could do. The ice would have us in kindling in another thirty minutes. The sea would drown us in five more; even in life preservers swimming men cannot live long in zero weather.

Most of the men came aft. They knew our boats wouldn't last a minute in the ice even if we could get them launched. As Newfoundlanders, they knew many a ship had gone out and never come back, leaving no trace. It looked as if we'd soon be another such mystery.

SCARED? Not exactly. I guess we felt more angry than scared; sore at getting such a tough break and not having a chance to do anything about it.

Then all of a sudden the *Leopard* seemed to get more on an even keel. At first I thought I must be growing a little weak-minded. But the wash had stopped. And I could begin to *hear* the ice, instead of just feel it. I held a lantern over the side. Instead of black water I saw a rough white surface.

Providence had been good to us. We had been blown in among the heavy ice jammed against Wreck Point about a hundred miles north of Brigus, where my home is. But the floes were grinding and the bumps we had been getting changed to ugly pressure.

Streaks of dawn were just showing in the east when the chief and his dirty gang came out of the engine room.

"We quit," he said. "She's stove in all along the port bilge."

I ran to the rail and saw that the floes had cut into her lower timbers like a knife into cheese.

We ripped spars and timbers out of her until we could lay a sort of walkway over the trash ice alongside. While we worked, the foremost shrouds popped like rifle shots and the whole shebang went over the forecastle with a noise like a warehouse collapsing.

SCARCELY had we got onto the slush ice than the *Leopard* went down. She didn't splash or corkscrew; she just seemed to melt into the ice. It was a hard sight for us who had called her our ship.

Slipping and falling, we somehow made our way across the floes to the rocky beach. We were done in by the time we touched dry land. Only it wasn't dry, on account of the snow flurries that still blew in off the sea. There was a bit of wreckage there, the bow of the old *Delmar*, which had foundered here some years before. We crawled in, wet and shivering, and waited for daybreak. Some

Captain Bartlett lashing empty drums under his schooner, the *Morrissey*, when she ran on a reef in north Greenland in 1926. She came off three days later.

"As I plunged in, the shock of the cold water on my bare skin was just like getting a thousand volts of electricity."

fishermen found us later and saved our lives.

* * *

Captain Bartlett shook his head as he ended his recital, which was taking place in the tiny after cabin of his schooner *Effie M. Morrissey*. Before him on the one deal table lay a chart outspread.

"THERE'S the spot," he said reverently, marking with a thick thumb the unmarked grave of his last sealing ship.

In the brief silence I studied this famous mariner, trying to see what it was in him that kept him perpetually at his hard calling. Weighing over two hundred pounds, all solid brawn, with a ruddy weather-beaten face, voice hoarsened by forty years at sea, he made a fine picture of a seaman.

"Not many real sailors left." I spoke my thought aloud.

Captain Bartlett sprang to his feet, nearly knocking a fine sextant on the deck.

"*Real sailors!*" he snorted. "There ain't one man out of fifty that goes to sea today who knows what sailoring is! Monkey-wrench sailors is what we've got! Good to grease a bearing and tighten a bolt. But when it comes to passing an earring on the main yard—!"

Loudly the captain blew through his nose and glared at me until I felt as if it were somehow my fault.

I quickly changed the subject. "You've seen mutiny?" I asked.

"Mutiny." He rolled the word on his tongue, lifting a corner of his upper lip as if it were distasteful.

"Yes, friend, I saw it on the *Solent*. I'd rather not give her real name, as her owners are still in business. In the late fall we shipped a cargo of Newfoundland seal oil and hides for a European port. It came on to blow; not a full gale, but a smart breeze that kicked up a nasty sea.

"ABOUT a week out of port we ran into really dirty weather with overcast sky, patches of raw fog, and the wind still holding. As luck would have it our rudder gear jammed. On account of the heavy sea running we couldn't get it fixed.

"For the better part of another week we drifted until we were clear of the trade routes. Then the ship's company began to fall ill. First, we thought it was a case of food poisoning. But the symptoms told us it was something worse.

"AS YOU know, the old ships carried no doctor. Medical equipment was all put in a small chest which the captain kept. In the top of this chest was a book of instructions. If a man had a pain in his side, fever, vomiting, and a rash, the captain simply wrote those things down in a list and looked up the disease in the book that corresponded. Then he'd get the proper medication out of his chest and administer it.

"You can imagine our feelings when we learned from the cook, who had it from the mate, who had it direct from the captain, that there wasn't anything in the book that fitted the symptoms our sick men were having!

"One man died. Another lay dying. A dozen were stricken. There began to be mutterings. At night in the forecastle the deck hands gathered and discussed the terrible situation. There we were, a drifting derelict, miles from the routes ships traveled, and a mysterious malady sweeping down upon us like a curse.

"'It's all right now, lads,' the mate told us one morning, a day or two later. 'We've got the rudder fixed and we're going on.'"

"On that same day a big sailor we had aboard, a man who had once been in command of his own vessel, but had been reduced for drinking, declared that if any of us were going to get home alive the ship ought to be taken west to the nearest port instead of east to Europe. He figured we could reach medical help in a few days if we turned about.

"By night he had won the crew over to his way of thinking. A committee went to the captain and told him they thought he ought to put back west to save us all from dying of the disease aboard.

"THE captain nearly had apoplexy. He was a heavy-set man; domineering and very strict. '*Mutiny!*' he shouted right off. 'I'll mutiny you—you loafers!' With that he grabbed a belaying pin off the starboard after rail and rushed for the spokesman, who nearly fell down a hatch trying to keep from having his skull fractured.

"That night the crew tried to capture the ship. I couldn't join either side because I was flat on my back with pains and fever. But the captain, mate, cook, and two loyal sailors were ready for the trouble makers. The captain didn't pay much attention to any but the leader. He grabbed him and threw him over his shoulder like a professional wrestler. Then he had the mate bind him and lock him in a lazarette under the cabin.

"At seeing their leader captured the mutineers lost heart that night and decided to wait until daylight. In the morning the captain made some of them come up and talk to him. In his hand he had a big revolver, the only firearm on the ship.

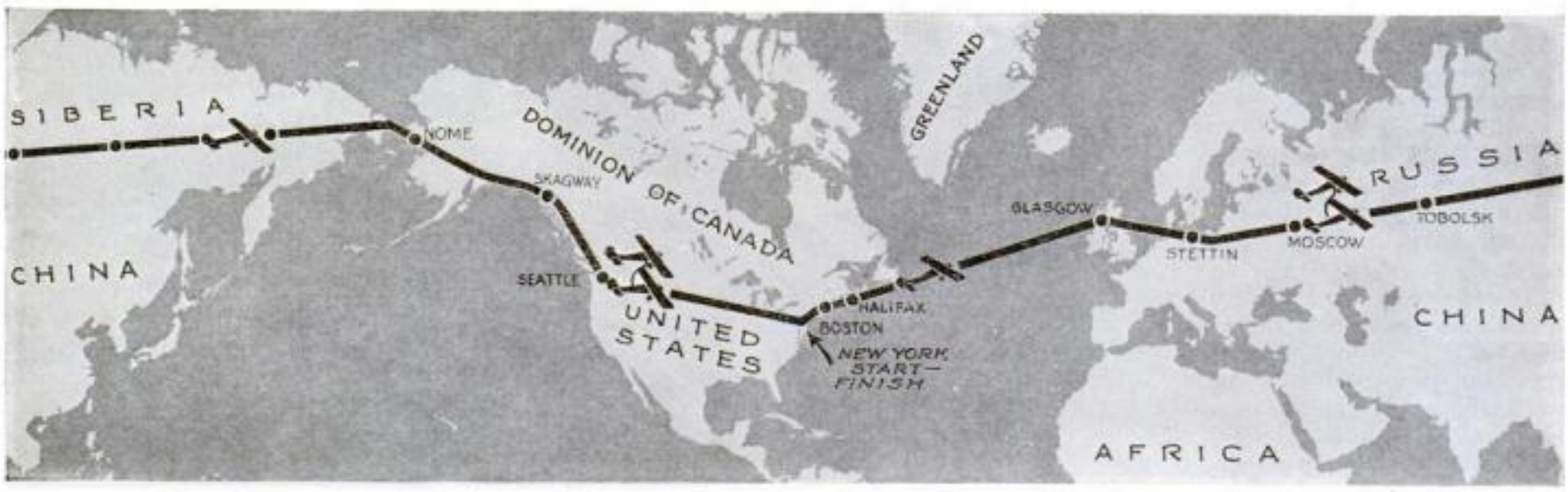
"'We've got the topsails on her,' he told them. 'The mate and the cook and I will steer. If you don't want to set any more canvas it'll take us maybe two months to reach port. If you want to make sail we can make it in three weeks with some luck. Take your choice. But meanwhile don't (Continued on page 139)

Captain Bartlett sighting through his sextant—a fine picture of a seaman, all solid brawn, with ruddy, weather-beaten face, voice hoarsened by forty years of life at sea.

"We ripped spars and timbers out of her until we could lay a sort of walkway over the ice."

The Viking, Newfoundland sealer, in which Captain Bartlett's father went seal hunting for many years. It was in this same *Viking* that the explorer Nansen, as a lad, first went into the Arctic.

Keeping Pace with Aviation



Route of proposed nonstop flights around the world. Circles along the course indicate points of contact with refueling planes.

Three Plan to Girdle World—Nonstop!

THREE nonstop flights around the world are in prospect. Each of three intrepid air adventurers has his mind set on being the first flyer to circle the globe by airplane without setting wheels on the ground.

The three are Art Goebel, Dole flight winner across the Pacific; Parker Cramer, co-pilot on the ill-fated *Greater Rockford* flight, and Albert D. Hulse, U. S. Army Reserve, former air mail flyer on the New Orleans-to-Pilottown route. All three are assembling equipment, plotting routes, and locating refueling stations.

Aeronautical experts regard the undertaking as the greatest aerial venture ever planned. The route to be followed will cover approximately 13,500 miles, and from five to five and a half days will be required to complete it.

The amazing refueling endurance flights of the *Fort Worth* and of the Army plane *Question Mark*, described in an article on page 17 of this issue, gave ample demonstration that a nonstop around-the-world flight is possible with the proper equipment. In fact, these flights inspired Goebel, Cramer, and Hulse to plan the attempt.

HULSE has announced that his plane will be equipped with five 420-horsepower motors, capable of a maximum speed of 120 miles an hour and a cruising speed of 110 miles an hour. Only three motors will be used in flight. The other two will be kept for emergency. The plane, he said, will be of metal and linen fabric construction, built to accommodate a crew of six with a compact galley and sleeping quarters. Its gasoline tanks will have a capacity of 1,900 gallons, sufficient for the long, overwater hop from Nova Scotia to Scotland.

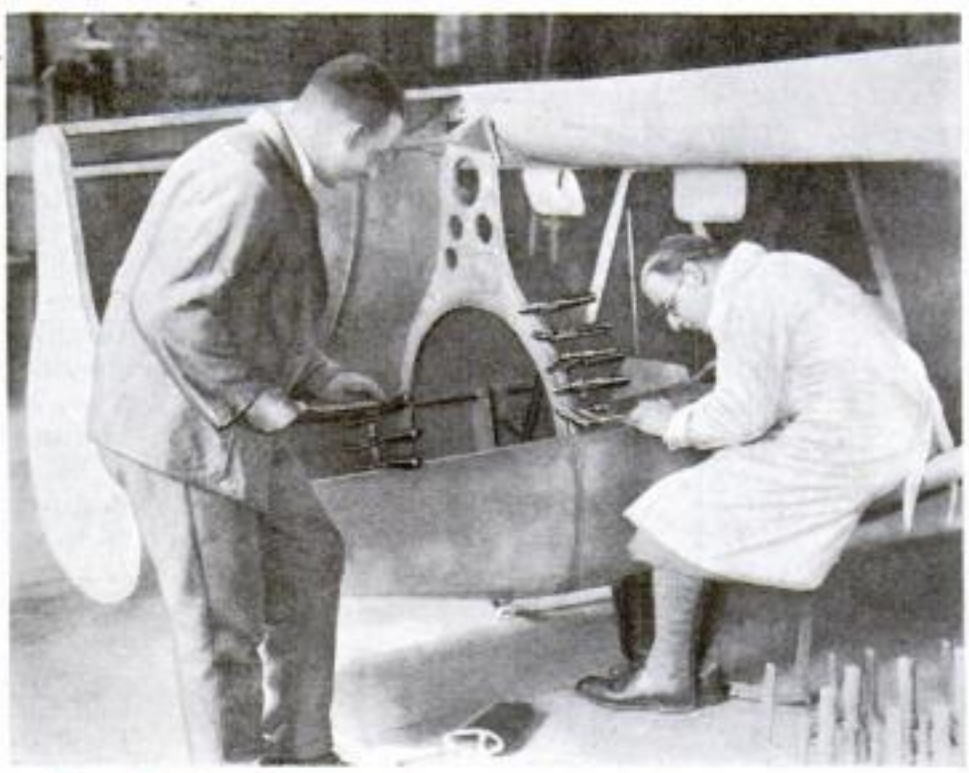
Hulse proposes to start from Roosevelt Field, New York, the early part of October. His route will carry him up the New England coast to Boston, to Nova Scotia, across the Atlantic ocean to Scotland, over Germany and Poland, across Moscow, over northern Siberia to Nome, Alaska, down the Pacific coast to Seattle, Wash., and then across the northern part of the United States to New York.

Twenty-two refueling stations are to be established. Ten of these stations are to be used only in emergency. The refueling planes will be similar to those used to keep the *Question Mark* in the air for 150 hours.

HULSE'S plane will start from New York with its gasoline tanks only half filled. When over Boston, it will be met by the first of the refueling ships and the tanks filled. This is because the danger of fueling while in flight is much less than that of attempting to take a heavily loaded plane off the ground. Trying to take off with too heavy a load caused the failure of many attempted trans-Atlantic flights. Motors which would be severely taxed to lift a heavy fuel load from a dead start are capable of lifting twice the load while in flight.

A second refueling plane will meet the around-the-world ship over Nova Scotia and the tanks will be filled to capacity for the long water hop. The first of the refueling planes in Europe will meet Hulse's ship off of Glasgow, Scotland. Other refueling contacts will be made over northern Germany—Stettin; Moscow, Siberia, Nome and Juneau, Alaska; and at Seattle, Wash. Emergency refueling stations will be located across the United States, but they are not expected to be needed.

The flight across the Atlantic and over the waste lands of Siberia will be made at an altitude of from 14,500 to 20,000 feet to benefit by the strong westerly winds which prevail at these heights during the early fall.



First Rocket Plane. Fritz von Opel, the German sportsman who helped develop the spectacular rocket automobile, is seen at the right working on a bullet-shaped monoplane—a winged skyrocket which he hopes to fly by the same means. Metal compartments at the rear will hold the rockets, whose recoils are counted on to propel the plane.

Huge Flying Boats for Great Lakes Service

GIANT air boats, each holding as many people as a standard sleeping car, are to link Cleveland, Detroit, and Buffalo in a new Great Lakes air line. The metal hulls for the first two of the boats are reported under construction at Lake Constance, Germany, by the Dornier-Wahl Company. When completed, they will be shipped to this country and fitted with American motors and furnishings. Each plane is to have four 500-horsepower motors, an innovation which Col. Charles A. Lindbergh recently prophesied would be the next step in increasing safety of air passenger travel.

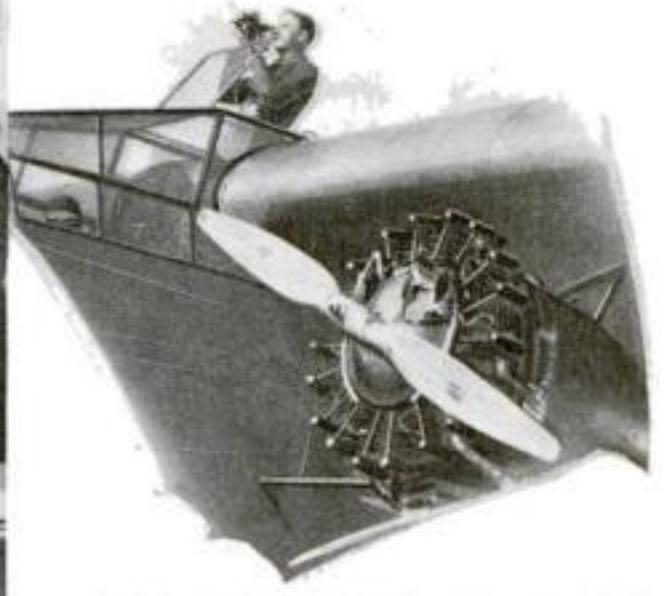
The plan is for the winged boats to fly at an average height of about 200 feet during the speedy trips which are expected to save almost an hour between Cleveland and Detroit. Constant radio communication will be maintained with the shore. Lunches will be served in the air.

The designer of the hulls, Dr. Dornier, is said to be completing, in Germany, a

Learning to Navigate

U. S. Army pilots are being taught the technique of navigation at a special school recently opened at Wright Field, Dayton, O. Experts give instruction in astronomical methods, dead reckoning, and radio direction finding. Here a group of students are shown learning to use sextants.

Operating radio instruments of the practice plane—one of the essentials of the course.



A student taking a sight from forward cockpit of a monoplane used as a flying classroom.

gigantic, twelve-motored air-and-water boat. It will have a total of 6,000 horsepower, equivalent in output to five hundred motors like the one that drove the original Wright biplane in 1903!

Other sky monsters are projected for air travel in Europe. An all-metal, fifty-five-passenger Handley Page biplane is under construction for the Imperial Airways in England. Besides a main cabin for forty passengers, it will have a number of "private staterooms" holding one or two people. The big air liners will be used on the London-Paris airway.

The largest land plane in the world, a hundred-passenger Junkers, is reported being built in Germany. It is designed to fly at high altitudes, its equipment including superchargers for the motors and oxygen outfits for passenger cabins.

Air Mail Saves a Day

A WHOLE business day is clipped from the coast-to-coast journey of air mail by a new flying schedule recently inaugurated. Two nights and a day, instead of two days and a night, make up the flying time of the planes, which cover two thirds of their trip in darkness. Thus, letters posted in New York at six o'clock in the evening are scheduled to reach San Francisco before the opening of business on the second day following.

The installation, by the U. S. Department of Commerce, of beacons at ten-mile intervals over the western end of the route, has made night flying comparatively safe all along the airway. The old service, leaving in the morning and arriving the second evening following, will be continued. Thus two transcontinental air mails each day will be provided.

Exactly seventy years ago the first stagecoach line to California began carrying mails from St. Louis. It enabled a letter to go from coast to coast in the surprisingly speedy time, for that period, of twenty-four days. When pony express riders, a few years later, began racing across the plains in relays, they cut the time to twelve and a half days. The fastest mail trains of the railroads still require almost eighty-three hours for the journey that the latest air mail service has reduced to thirty-two.

New 500-Mile Beacon

A WHEEL of light, a thousand miles in diameter, will have its hub at Chicago when the colossal 2,000,000,000-candlepower searchlight, recently offered the city by Elmer A. Sperry, New York inventor, is installed. The $100,000 aerial beacon is to be named "Lindbergh Light," in honor of Col. Charles A. Lindbergh. It will revolve at the top of a 125-foot tower on the roof of a lake-front skyscraper.

On clear nights, its beam, reaching 500 miles, is expected to sweep in a circle that will touch twelve states—one fourth of all those in the Union! It will be visible to night flyers from Buffalo, N. Y., on the east, to Omaha, Neb., on the west and from the Canadian border above the Great Lakes, on the north, to Memphis, Tennessee, on the south!

The light, it is said, will actually be more dazzling than that of the midday sun! At Chicago, on the hottest days, it is computed that the sunlight's intensity does not exceed 900 candlepower for each square millimeter, while at the lamp, the illumination sent forth surpasses this intensity by almost 100 candlepower.

Aerial Photos by Night

AN AMAZING "cat's-eye camera," which takes aerial photographs at night unseen, was demonstrated recently during the war games in Ohio, in which almost 200 fighting craft of the sky took part. The instrument, the secrets of which are closely guarded by the U. S. Army, is designed to enable observation planes to photograph enemy troop movements or the activity around military centers under cover of darkness.

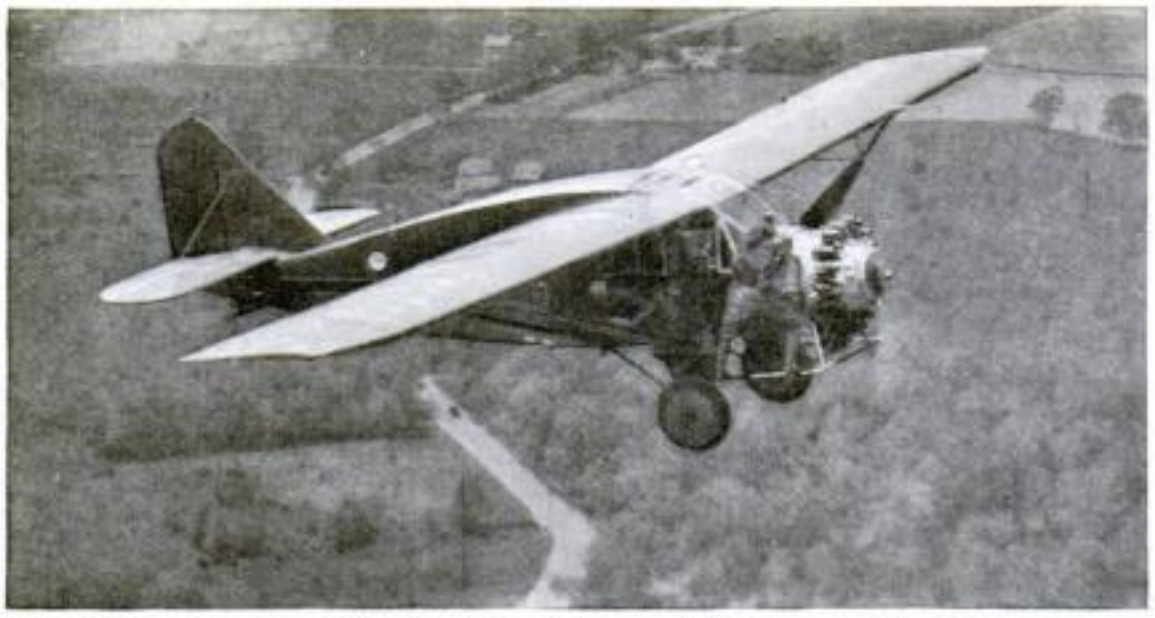
The camera is described as being synchronized with a flashlight apparatus whose illumination is so instantaneous that it does not register on the human eye. Exposures made during these quicker-than-the-eye flashes may be developed while the plane races back to its own lines and can be dropped at headquarters by parachutes, placing them in the hands of Army officers within ten or fifteen minutes after they have been taken. Because the flash is invisible to human eyes, it is said, the camera will enable silent planes to circle over the enemy in the dark, taking photos without their presence being known.

An Airplane "Plow Horse." As part of the ceremony of breaking ground recently for a new airplane factory at Fairfax Field, Kansas City, Kas., a big biplane was hitched like a horse to a farm plow which it dragged down the field. This photo shows the mayors of Kansas City, Kas., and Kansas City, Mo., doing their best to guide the outfit. An idea any farmer might try.

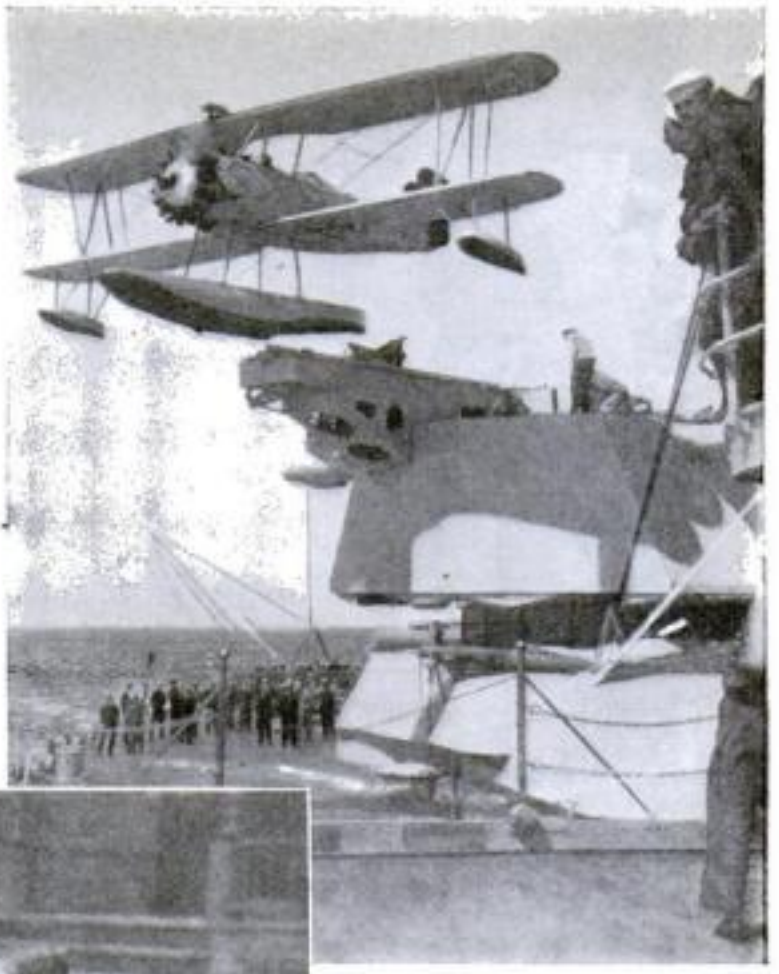
A Box of Fog

A "coffin" filled with fog is part of the equipment being used by the Massachusetts Institute of Technology, Cambridge, to learn more about this enemy of airmen. The long wooden box, tightly sealed, is filled with vapor from a boiler and a beam of light is shot through the artificial fog bank. A

(Continued on page 29)



A Perilous Perch. This sky photo pictures a thrilling moment in the recent unsuccessful attempt of Martin Jensen and two comrades to break the world's refueling endurance record in monoplane *Three Musketeers* above Roosevelt Field, N. Y. It shows Jensen on the catwalk, in full blast of the propeller's backwash, repairing a gas leak.

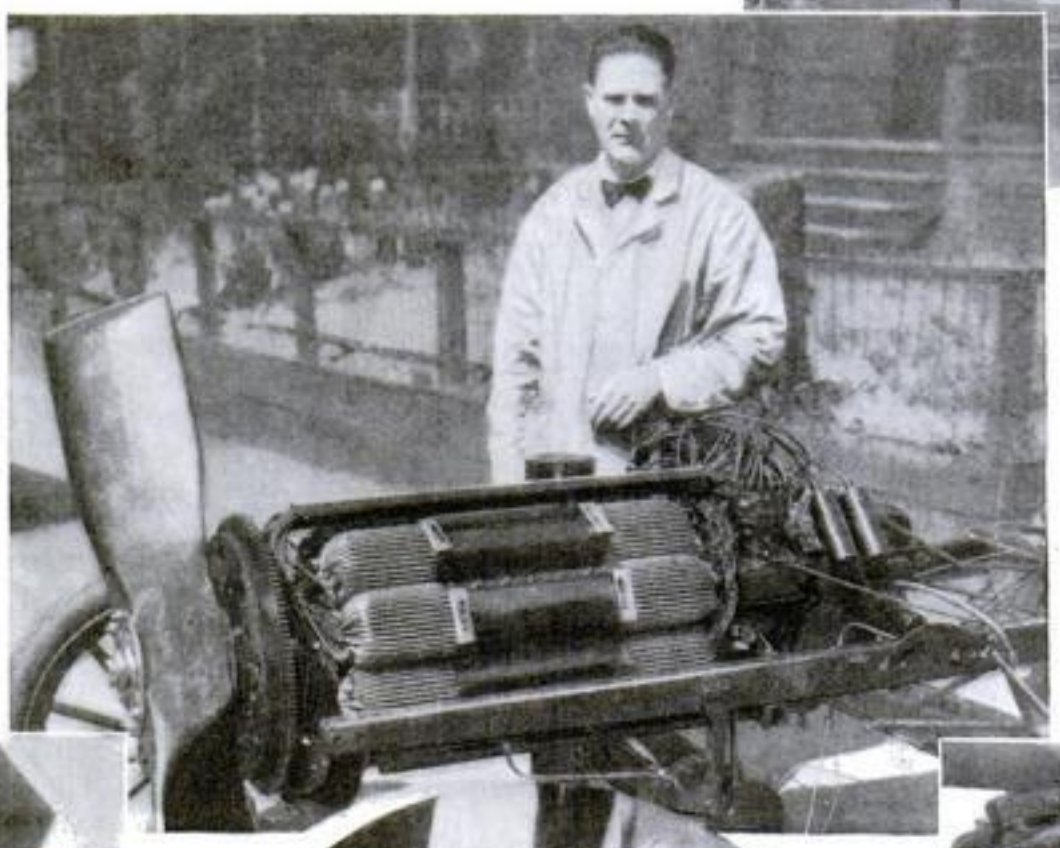


Shot from a Warship

Recent maneuvers and battle practice of Uncle Sam's Pacific Fleet off southern California demonstrated the vital part scouting and observation planes will play in future naval engagements. This photo was snapped just as a big Navy observation seaplane was catapulted from the deck of the U. S. S. *Tennessee*.

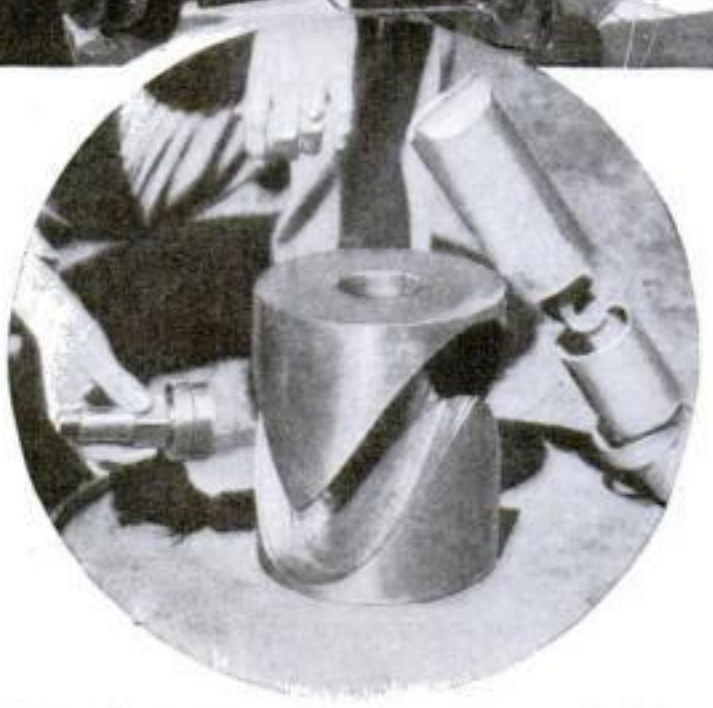
New Valveless Motor

A remarkable new type airplane motor, featuring sixteen air-cooled cylinders without valves, is shown at the right with its inventor, G. E. Franklin, president of the Franklin Aeronautical Corporation, during a recent demonstration at Kansas City, Mo. He predicts that it will bring radical changes in the design of both aircraft and automobile power plants. Weighing 359 pounds, the new engine is said to develop 400 horsepower, or better than one horsepower per pound. Franklin began work on the invention soon after the close of the war. Unusual parts of the motor, including substitute for crank shaft, are shown in circle below, center.



Maps Alaska from the Air

A ribbon of photographic film longer than a city block feeds into this newest automatic aerial camera, used by the Government expedition, led by Lieut. Com. A. W. Radford, above, which is mapping 10,000 miles of uncharted Alaskan territory. The instrument makes four exposures simultaneously: one downward, one ahead, and two at the sides of the line of flight.



Parts of new motor. Cam that replaces crank shaft (center); double-ended piston (right); connecting rod.

NEW airplanes, airports, airways—they're coming so fast that it's a lively task to keep informed of them all. Pictures and brief articles on these pages give you a clear and fascinating view of the important advances in aviation.

"Lindy" Oils the Family "Car"

Before—and after—Col. Lindbergh's recent marriage to Anne Morrow, daughter of the American ambassador to Mexico, he led reporters a merry chase by his frequent and unheralded flights. Here he is standing in the rain at Portland, Me., greasing motor of plane he flew from Maine to New York with his bride-to-be and members of her family shortly before the wedding.

photo-electric cell permits recording of the amount of light that penetrates the vapor. Various kinds and colors of light are being tried.

Real fog banks, coming in from the sea, are also studied with special instruments sent aloft on captive balloons and kites. The experimenters hope to develop a means of classifying fog, and measuring accurately the visibility on different days, thus giving more exact information to cross-country flyers.

Checking the Air Records

GO TO the Bureau of Standards, Washington, D. C., some day after you have read in your newspaper of an American aviation record being broken, and you will find a studious young man working with strange looking instruments, retracing the flight and determining to a mathematical precision just how much the new record exceeds the old one.

This man, who has the final say on whether a new mark has been set, is H. B. Henrickson, assistant physicist in the Aeronautical Instruments section.

Whenever a flyer tries for a record, the barograph, or recording instrument carried on his airplane, is forwarded to Henrickson for computation. He removes the smoked-chart cylinder, on which atmospheric pressure has left its tale-telling trace by means of a stylus, and places it in a "fixing" solution to preserve a more or less permanent record of the flight.

The entire barograph, with the exception of the outside cover, is placed under a specially prepared bell-jar. There, with the clockwork mechanism of the instrument ticking away and a stylus following the waving, scratched line left by the flight, Henrickson is able to follow every movement of the airplane on its record-breaking attempt.

This process is called the "flight history test," in which temperature and pressure and rate of change during the flight are duplicated.

In an altitude flight, for example, Henrickson will start the stylus of the pen arm on the ground pressure line of the barograph chart. The air is exhausted at a rate approximately the same as that shown by the trace until the lowest, or "ceiling" pressure of the flight is reached. A pressure reading is taken on a standard mercurial barometer connected to the bell-jar. This pressure is then converted into feet altitude.

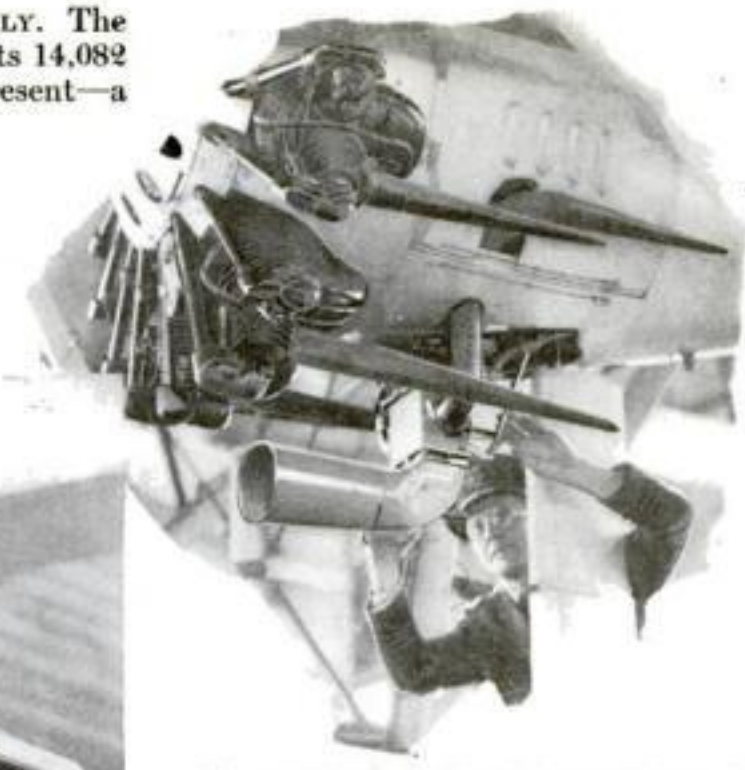
Reproduction of temperature changes are necessary to accurate reading of the chart. Henrickson has invented a simple airplane thermometer, which is attached on wing struts, to give an accurate record of temperature changes.

Student Pilots

NEARLY fifteen thousand American young people are experiencing the thrills of learning to fly which Larry Brent has been recounting in POPULAR SCIENCE MONTHLY. The Department of Commerce reports 14,082 student pilots licensed at present—a number that could man all of the war planes flying on both sides of the trenches at the end of the World War. A year ago there were only 2,235 licenses of all classes, from students to the highest rank of transport pilots, registered in the United States.

Cures Engine Cough

Commander Karl Smith, U. S. Navy, with device he has invented to clean air entering carburetor of a seaplane engine, thus preventing spray water from stalling the engine.



The new air cleaner installed on seaplane. Inrushing air, whirled by vanes, is freed of water.

Because commercial air transport companies eagerly seek pilots with Army flying experience, a special ruling was recently made to attract flyers to fill the depleted ranks of the Army Air Corps. Civilian pilots will be accepted for one year's service and given the rank of second lieutenant, Major General James E. Fechet, Chief of the Air Corps, announced recently.

Airplane thermometer that was devised by Henrickson to record temperature changes.

Aviation's Referee

H. B. Henrickson, assistant physicist in the Aeronautical Instruments Section of the Bureau of Standards, checking barograph used by Lieut. Soucek in altitude flight of 39,140 feet. Right: Temperature recorder on strut.

Plane Dispatchers Now

AT ONE end of the long runway at Roosevelt Field, New York, a man in white overalls waved a red and a green starters' flag the other day, inaugurating a new safety feature at the famous American airport. As airplane dispatcher, he signaled the machines when to start and kept the field clear of taxiing planes when pilots were preparing to land.

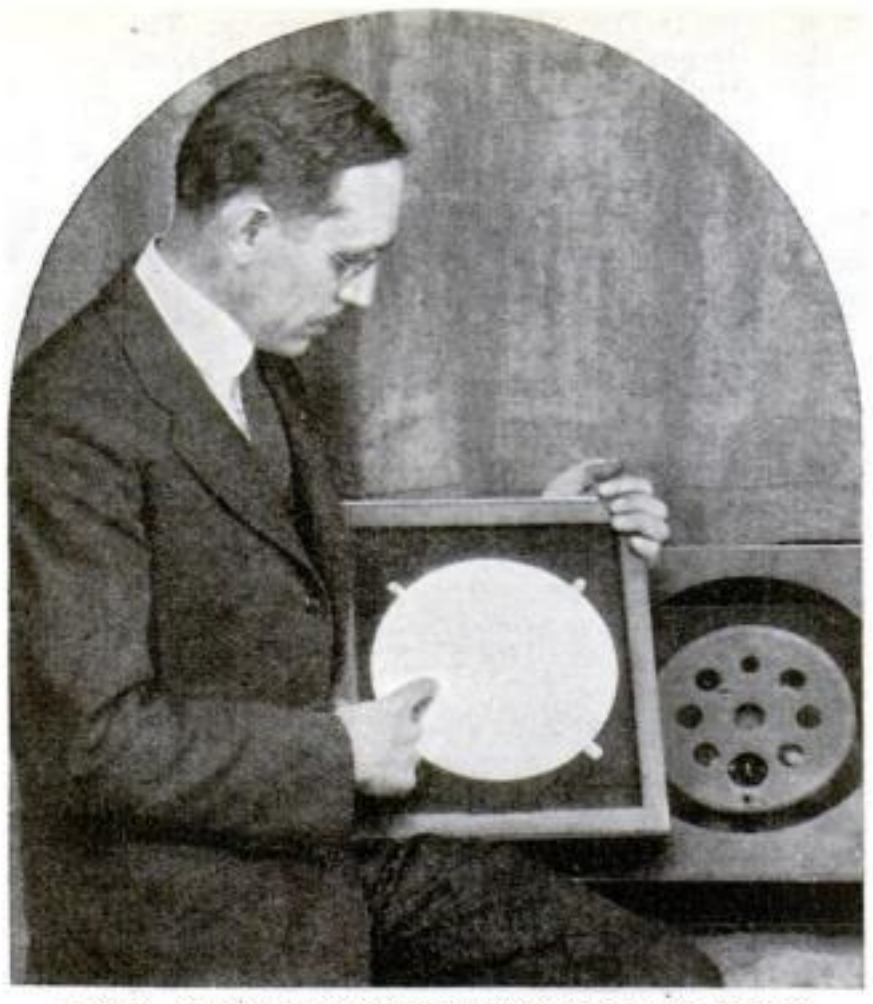
Starters with their flags have been a familiar sight at flying meets, but few airports in this country have used them. Now that the planes at large air fields are as numerous on ordinary days as they used to be at aviation meets, control of the traffic is needed.

A Monoplane-Biplane

A MONOPLANE in the morning; a biplane in the afternoon! You can take your choice of which kind of craft you will have, if you own a Belgian machine recently demonstrated in this country. Interchangeable wings allow it to be converted quickly from one type of machine to the other. King Albert of Belgium, who is a skilled aviator, flies one of the convertible machines.

Safety Overalls

LABORATORY experimenters found, some years ago, that orange-colored objects are most easily seen from a distance. Now an air field at Kansas City, Mo., announces that its attendants will wear orange overalls, so that pilots preparing to land can see them readily.



John F. Peters, Westinghouse consulting engineer, with the klydonograph he invented to take "fingerprints" of lightning.

People in the Public Eye

THE Franklin Institute of Philadelphia the other day presented the Edward Longstreth Medal for meritorious work in science to John F. Peters, consulting engineer of the Westinghouse Electric and Manufacturing Company, at Pittsburgh, for his invention of the "klydonograph," the only simple device in existence for "fingerprinting" the most elusive and deadly enemy of electric power transmission—lightning.

When lightning flashes from lowering clouds and strikes a modern transmission line, it cripples the power circuit and vanishes again, all in a few millionths of a second. Yet, in that incredibly brief space of time, the klydonograph takes a rogues' gallery picture of the marauder and its Bertillon measurements. In fact, the device, in laboratory tests, has recorded artificial surges lasting less than ten billionths of a second!

Until Peters perfected his amazing little apparatus, there was no way of gathering the evidence lightning leaves after striking power lines. To protect them from this menace, scientists must know the enemy's characteristics. How powerful is it? How fast does it strike? How long does it stay? Which way does it go?

Lt. A. J. Williams, known as "America's fastest flyer."

The klydonograph answers these questions. It is a sensitive eight-day camera, which now stands guard over many American transmission lines. It takes care of itself except for a weekly change of photographic film. Clockwork in the device tells the time of the lightning shock and turns the film spool. The size, intensity, and arrangement of the delicate lines in the developed klydonograph picture tell scientists all the peculiarities of the "fingerprinted" lightning bolt.

The man who invented this instrument never had the advantages of modern technical training. Born and raised on a farm near Chambersburg, Pa., he had to do his share of the chores and so rarely attended the one-room country school more than five months in a year. The result was that he remained in its classes until he was eighteen years old!

Peters' parents had decided to make a carpenter out of him, and he followed that trade for a time, but he had made up his mind to become an electrical engineer and so he studied electricity and mechanical drawing in the evenings after work.

When he was twenty, the Westinghouse Electric Company refused him admittance to its two-year electrical course because of lack of technical training. Young Peters took a job as an electrician with the Pittsburgh Steel Company at Monessen, Pa., and doggedly continued his studies.

A year later, he again applied at the Westinghouse works and declared himself willing to do any kind of work. He was given a job in one of the shops and after three months was made assistant foreman of the section making D. C. motors. But Peters was not satisfied. Sacrificing a considerable portion of his foreman's pay, he secured a position in the Transformer Engineering Department. Meanwhile, for twelve years, he diligently pursued his evening studies of engineering, mathematics, and other subjects.

Henrietta H. Swope, of the Harvard Observatory staff, who discovered 400 new variable stars.

In 1918, Peters was made a free lance in the Transformer Engineering Department, devoting his time to consulting work and special problems. High-voltage transmission, continuity of power service, and abnormal voltage and current investigations kept him busy during the next few years. The klydonograph is one of several developments of this period.

In 1925, Peters was appointed consulting engineer for the entire Westinghouse organization. A little over forty years old, the man who, twenty years ago, lacked sufficient technical training, today has more than thirty patented inventions!

Genius of Bridges

THE U. S. War Department recently had under consideration a plan, submitted by the North River Bridge Company, of New York City, to build a railway and highway suspension bridge across the Hudson River from Fifty-seventh street in Manhattan to the New Jersey shore. It called for a double-deck structure with a single span of 3,240 feet, to be connected on the New York side with a great union passenger station. The new bridge would accommodate at least 40,000,000 vehicles, 400,000,000 passengers, and 25,000,000 tons of freight per year. Its cost is estimated at about $200,000,000.

Gustav Lindenthal, designer of famous bridges and tunnels.

The designer of this gigantic project, who originated it some thirty-five years ago and has been working for its realization ever since, started his career in this country as a stone mason in the grounds of the Phila-

(Continued on page 135)

Has Our Earth a Glass Heart?

By

JOHN E. LODGE

IF YOU could put the earth under a super X-ray machine and look clear through its vitals—what would you see?

You would be startled to find that the "heart" of our planet is an immense sea of liquid glass, taking up about half of its 7,900-mile diameter!

Surrounding this great molten-glass core, you would observe a layer of metal, probably 1,000 miles thick—the distance from New York to Chicago!—and resembling the iron found in meteorites. Above that, you would come upon a stratum, again about 1,000 miles in depth, consisting of dark-colored fire-formed basalt rock. And finally, you would notice that the outer "shell"—the earth's crust on which we live—is a comparatively thin skin composed of granite reaching to a depth of only some thirty miles.

How the earth's interior might appear if we could put it under a giant X-ray machine—a drawing based on the remarkable new theory advanced by Dr. R. A. Daly, noted Harvard geologist.

THAT, at least, was the imaginary "X-ray photograph" of the earth's interior projected a few weeks ago by Dr. Reginald A. Daly, professor of geology in Harvard University. His theory of the liquid glass core enveloped by successive layers of iron, basalt, and granite is at complete variance with that of a number of other scientists, who still assume that the earth is "a molten ball of fiery material with only a very thin crust between man and realistic hell-fire."

The planet's "glass heart," according to Dr. Daly, is subject to the inconceivable pressure of 50,000,000 pounds on each square inch, and to the intense heat of 50,000 degrees centigrade!

The continents and oceans on which we live, the Harvard geologist said, are in constant process of sliding and floating on the great glass sea that occupies the earth's center. This motion, causing landslides of enormous blocks of the planet's surface, is responsible for earthquakes, volcanoes, and the formation of mountains.

What probably happened, according to Dr. Daly, was this:

The earth developed from gases pulled away from the sun. Millions of years ago, while these gases were being transformed into liquids and semisolids, the planet met with a gigantic catastrophe, in the course of which a huge chunk of it, which later became the moon, was hurled into space.

This early disaster may have been caused by tremendous tidal waves rolling over the earth or by the fact that it was pear-shaped and lopsided at the time. At any rate, the planet has never quite recovered from that cosmic accident and ever since then has shown a tendency to correct its distorted, unfinished shape and perfect its symmetry.

The "landslides" of the earth's outer crust and the crumplings on the downside of these slides, which cause mountain ranges to rise and great masses of lava to spout to the surface, are probably the results of the unceasing tendency of gravity to overcome the planet's original distorted condition. In other words, whenever an earthquake occurs or a volcano erupts, the earth is putting forth another effort to make itself into a smooth, round globe.

Challenging the theory that the earth's heart is molten, Dr. R. R. Cummings, head of the Indiana University Department of Geology, recently declared that our globe is solid to the core and has resistance to change of form as great as if made of finest steel.

"The fact that the earth continues to rotate," he said, "is evidence of rigidity. Raw eggs will not spin about their long axes, due to internal friction of the liquid contents; hard-boiled eggs will."

He also cited the fact that great earthquakes shake the entire earth. And he contended that the center of the earth is a core of nickel-iron, with a radius of about 2,100 miles, immediately surrounded by a shell of magnesium and iron silicate about 440 miles thick.

Drawn especially for POPULAR SCIENCE MONTHLY *by B. G. Seielstad*

Reese—A Man Who Always Does the Impossible

By FRANK PARKER STOCKBRIDGE

HERE is the story of a man who has started a revolution, the end of which nobody can foresee—a chemical revolution. It is the story of an extraordinary man who helped win the war, and who has given us the opportunity to live better and more cheaply than ever before.

It is an intensely human article, depicting one of the marvels of our day.—The Editor.

OF ALL America's industrial and economic changes in these amazing ten years since the war, the most colorful, and in many ways the most important, is what may be termed the "chemical revolution."

Out of the laboratories have poured scientific discoveries which have transformed our world. Where we were drab, we are now brilliant with color. Where we dressed in cotton, we now wear rayon. Where we were dependent upon foreign sources for such essentials as fixed nitrogen for fertilizers and explosives, we now take our own nitrogen from our own air. And we do all of these things more cheaply and in larger volume than anyone dreamed possible, ten years ago.

Where we had fewer chemists working in industry than any other civilized nation before the war, we now have more trained chemical brains than there are in all of the rest of the world put together!

Behind every revolution there is a mind. Thousands of minds coöperated to bring the chemical revolution to fulfillment, but *somebody* started it. Who?

I asked chemists, industrialists, anybody who might know, to name the man who started the chemical revolution, who put chemistry into American industry. Some said this man and some said that, but most of them said "Reese."

SO I went to Wilmington, Delaware, to see Dr. Charles Lee Reese, founder of the great Du Pont chemical laboratories, for many years the company's chemical director, today a director of the corporation and its consultant on all technical matters.

"Is it true," I asked him, "that you won the war by discovering the chemical secrets of the Germans?"

That was one of the things that had been told me about Dr. Reese.

The dignified, courteous gentleman to whom I put the question smiled deprecatingly.

"Don't attribute too much to me," he said. "It is true, however, that we did succeed in surprising the German government and the German scientists at the very beginning of the war."

They had thought, the Germans, that they alone held the secret of smokeless powder. The essential ingredient, diphenylamine, the stabilizing element without which nitrocellulose powders cannot be made, came only from German laboratories. Even the great Du Pont company imported its supply of this chemical, a by-product of the great German aniline dye industry. Nobody else could make it, the Germans thought. Derived from coal tar and the manufacture of gas and coke, it was one of those carefully camouflaged chemical secrets for which the German chemical industry was famous.

But the Germans apparently had greatly underestimated Dr. Reese.

"The British had to have smokeless powder, instantly, in huge quantities," Dr. Reese told me. "They were caught unprepared for the war, and there was no place except the United States to which they could turn for ammunition.

"The British government offered us a huge contract for powder, with time limits so close that at the best our facilities would be severely taxed. We accepted the contract, although we did not know where we were going to get the diphenylamine essential for use as a stabilizer.

"My work since 1902 had been chiefly in the development of nitrocellulose powder for the United States Army and Navy. While in Germany, in 1908, I learned that German chemists, by the use of diphenylamine, had solved the problem of stabilizing nitrocellulose, to insure against premature or spontaneous explosion.

"I could not obtain the secret formula for its manufacture but I did arrange for a supply and we began making nitrocellulose powders for our own Government and others, as well as for industrial and sporting purposes, buying our supply of diphenylamine from Germany.

"Then Germany began the war and the world's supply of the essential stabilizer for smokeless powder was cut off.

"We *had* to find out how to make it. And we had to learn quickly."

IT WAS a problem complicated enough. America had no aniline dye industry—that was a German monopoly. America had almost no commercial supply of the coal-tar intermediates from which aniline is made, hence, no supply of the basic products from which diphenylamine was made in Germany. But Dr. Reese is not only a great chemist but a great organizer. He called his staff heads together.

"There are two ways that I think of by which diphenylamine can be produced," he told them. "We'll turn over one laboratory to one line of research, another entire laboratory to the other."

And to the heads of these two groups he said: "Hire all the additional chemists you need, requisition whatever supplies and apparatus you require. Go to it, both of you. Never mind the expense. Go to it—and *get* it!"

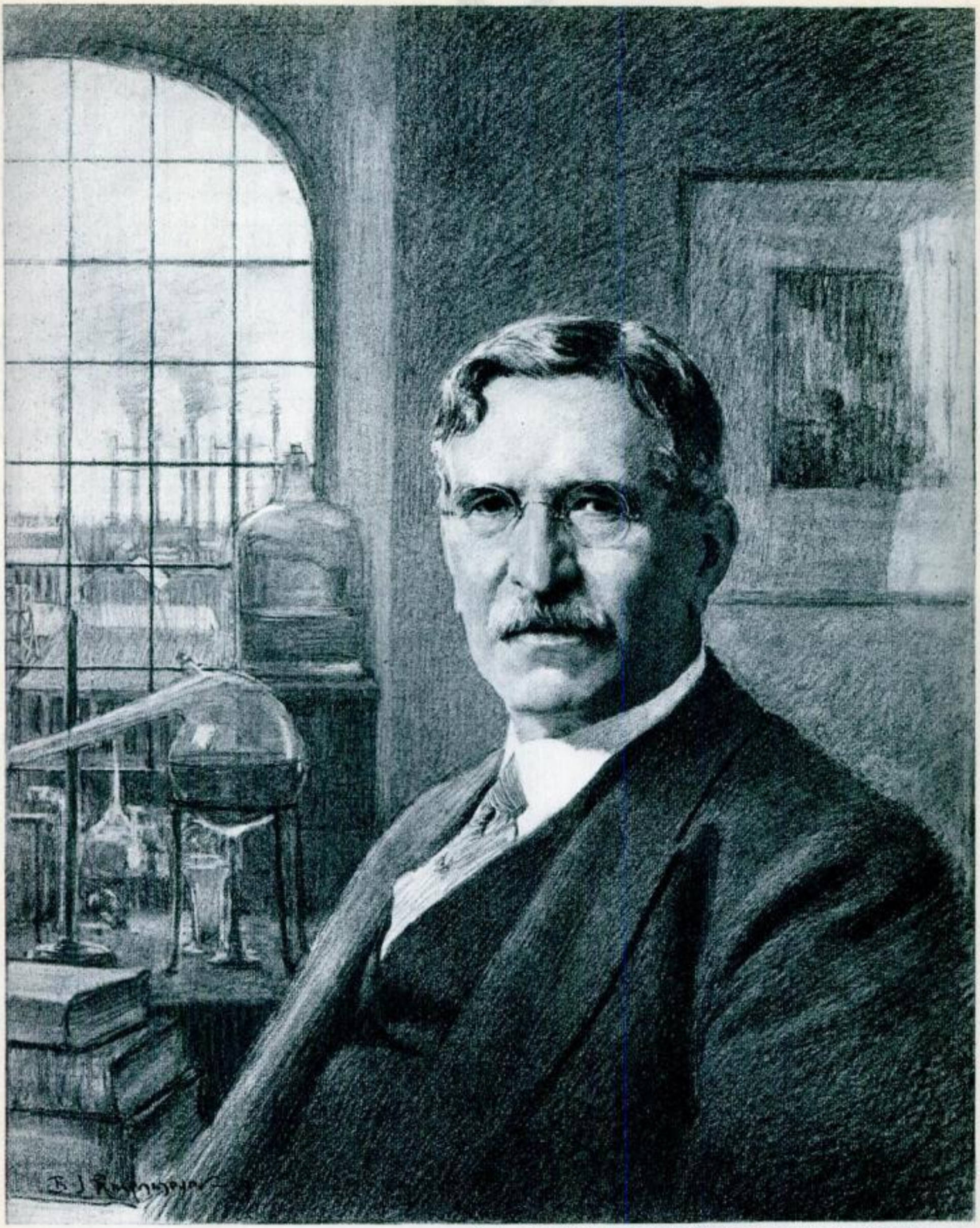
The laboratories went to it.

"WE TOOK the British contract and started production of smokeless powder at once," Dr. Reese told me. "I know that the Germans laughed at our confidence—they told me so, some of them, after the war was over. We could go only so far; then our supply of the stabilizer would be exhausted and we could make no more powder for England."

Day and night the laboratories operated, scientists worked in twelve-hour shifts, trying this reaction, testing that result. Meantime, so confident was Dr. Reese that they would succeed, that he did not wait until the answer had been found before arranging for supplies of the coal-tar products from which aniline is made.

Then one morning, Dr. Reese found the head of one of the two laboratories waiting at the door when he reached his office.

"We've found it, chief!" he exclaimed. "Here's a sample. *(Continued on page 130)*



Drawn Especially for POPULAR SCIENCE MONTHLY *by B. J. Rosenmeyer*

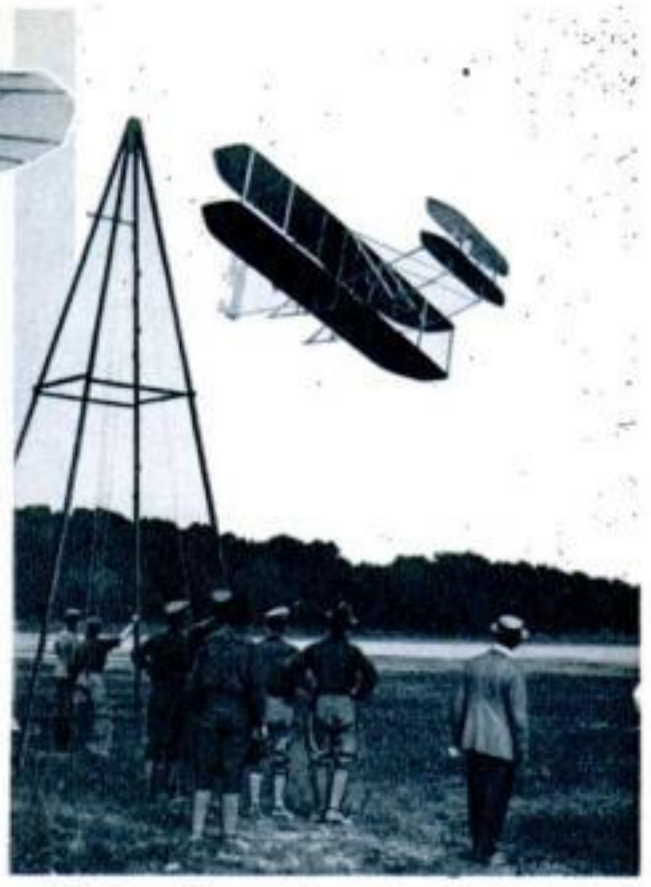
DR. CHARLES LEE REESE, Father of Industrial Research

DIGNIFIED schoolmaster, he taught industry how to draw fabulous wealth from research in pure science. From his work as founder and director of the great Du Pont chemical laboratories at Wilmington, Del., have come the beautiful, weather-defying finish of your car, artificial silks for your wife's stockings, dyes to make your world gay with colors, and many other wonderful products in everyday use. Today, at the age of sixty-seven, he still devotes his scholarly mind to the service of utilizing the discoveries of science for the benefit of us all.

Otto Lilienthal, German father of gliding, made first motorless flights in 1891. He was killed in glider crash in 1896.

In this birdlike glider Lilienthal made his spectacular flights by leaping from the top of a hill near the Baltic Sea in northeastern Germany. His daring feats led to the invention of the airplane.

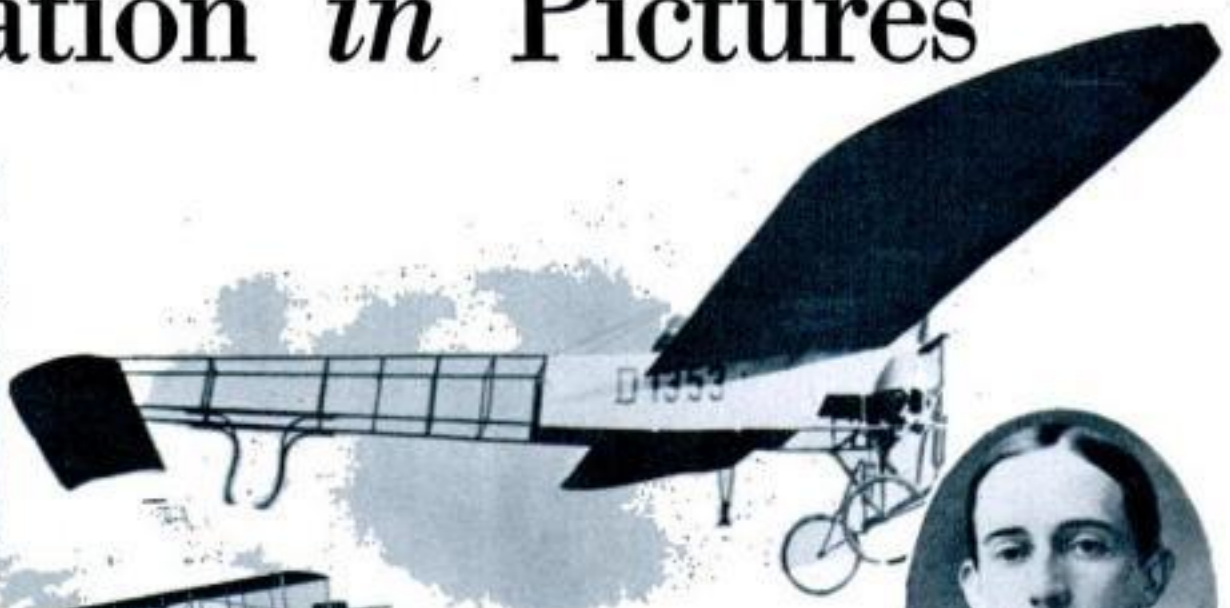
A pioneer machine that almost flew—Dr. S. P. Langley's "aerodrome" on a houseboat from which it was launched above the Potomac River, October 7, 1903. It crashed into the river, as it did in a second test.



The first military airplane—the Wright brothers' biplane successfully passing U. S. Government tests at Fort Myer, Va., July 30, 1909. Nearly six years earlier, December 17, 1903, the first successful powered plane, built by the Wrights, made its historic flight at Kitty Hawk, N. C.

Famous Flights—A Vivid Story *of* Aviation *in* Pictures

A pioneer in cross-country flying. Glenn H. Curtiss in his biplane at start of the historic Albany-New York flight, May 29, 1910. He won New York *World* prize of $10,000.



Monoplane in which Louis Bleriot, French airman, first flew across English Channel, July 25, 1909. Right: Alberto Santos-Dumont, who made first airplane flight in Europe, September 13, 1906—600 feet.

Adolphe Pégoud, first flyer to loop-the-loop, in the Bleriot monoplane he used for the stunt near Paris in September, 1913.

The first flight from the deck of a battleship—Eugene Ely, in an early Curtiss biplane, hopping from the U. S. S. *Pennsylvania* in 1911. A great event in the advance of naval aviation, and one which forecast airplane carriers.

Glenn H. Curtiss, inventor of the hydroaeroplane and flying boat, giving first public demonstration of a plane equipped with pontoons, at San Diego, Calif., January 26, 1911.

Mail arriving in Washington, D. C., from New York, after a flight establishing world's first regular air mail service, May 15, 1918.

First to fly the Atlantic. The U. S. Navy's flying boat *NC-4* in the Azores on the way from Newfoundland to England via Portugal. The flight began May 16, 1919; the plane arrived at Plymouth, England, on May 31.

The crew of the *NC-4*, first aviators to bridge the Atlantic. Lieut. Commander A. C. Read, commander of flight, is at extreme left. Sister ships, the *NC-1* and *NC-3*, also made the attempt, but were forced down at sea. Their crews were rescued. Patrol boats were stationed along the way.

Harry Hawker, British pilot who, with Commander Grieve, attempted a nonstop flight from Newfoundland to Ireland, May 18, 1919. They were picked up after falling in mid-ocean.

EVERY step in the advance of flying has been a romance of reckless daring and high adventure. How many of these past heroes and their thrilling feats do you recall? To them aviation largely owes its present status as a thriving industry.

First nonstop flight across the Atlantic. Capt. John Alcock (right) and Lieut. A. W. Brown, of the British air service, crossed from St. Johns, Newfoundland, to Clifden, Ireland, June 14, 1919, flying 1,960 miles in sixteen hours, twelve minutes, and winning London *Daily Mail* prize of $50,000. Upper photo shows their plane after the flight.

British dirigible *R-34*, first lighter-than-air craft to cross the Atlantic, landing at Roosevelt Field, N. Y., after 3,120-mile flight from East Fortune, Scotland. Starting July 2, 1919, the trip took 108 hours. The return voyage to Pulham, England, was without mishap. Major S. H. Scott, commander of the airship, stands at center in upper photo. At the extreme left is Lieut. Commander Zachary Lansdowne, American observer on the flight, who was killed later in the *Shenandoah* disaster.

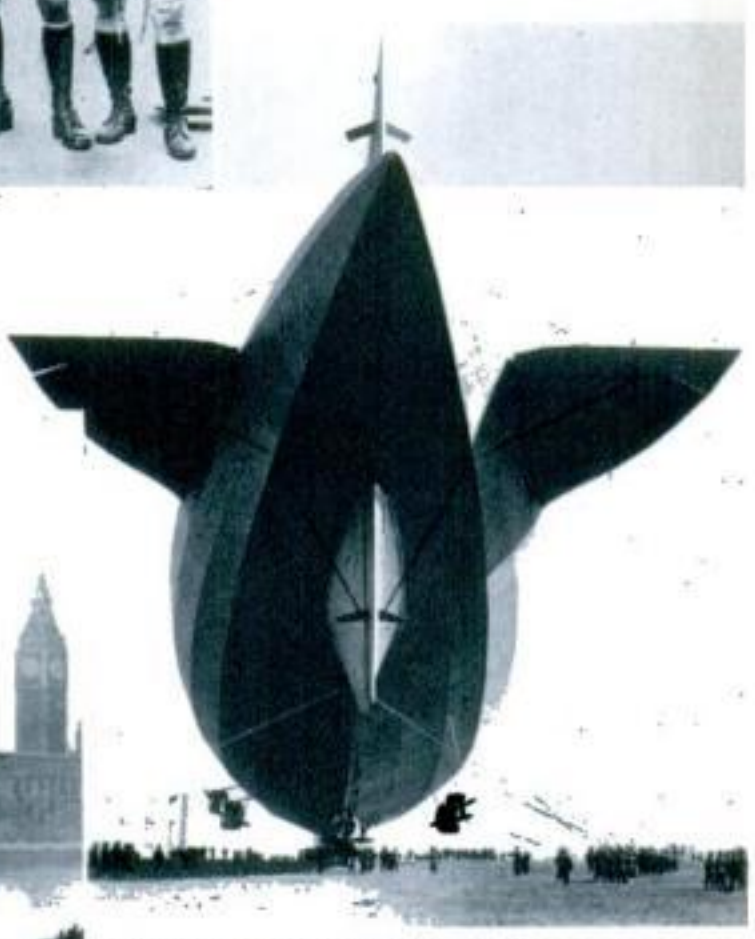
U. S. Army flyers, led by Capt. St. **Clair Streett** (third from left), who beat all records in **a 3,575-mile flight** from New York to Alaska, July 15-**August 24, 1920.**

First nonstop transcontinental flight. Lieut. Oakley G. Kelly (center) **and Lieut. James A. Macready** (left), **who flew from Mitchel Field, N. Y., to San Diego, Calif., May 2 and 3, 1923.**

Lieut. Russell L. Maughan (right) **standing beside the Army pursuit plane in which he made the first dawn-to-dusk flight across the continent, June 23, 1924.**

Three of the four Army round-the-world planes arriving over Long Island, N. Y., near the end of their 27,553-mile trip, in 1924. Leaving Seattle, Wash., April 6, they flew via Alaska, Japan, India, Persia, Turkey, Austria, England, Greenland, and Newfoundland. Two completed the flight safely on September 28.

Army round-the-world flyers in England. Left to right: Lieut. Leigh Wade, Lieut. Erik H. Nelson, Lieut. L. P. Arnold, Sergt. Ogden, Lieut. Lowell Smith, and Lieut. J. Harding.



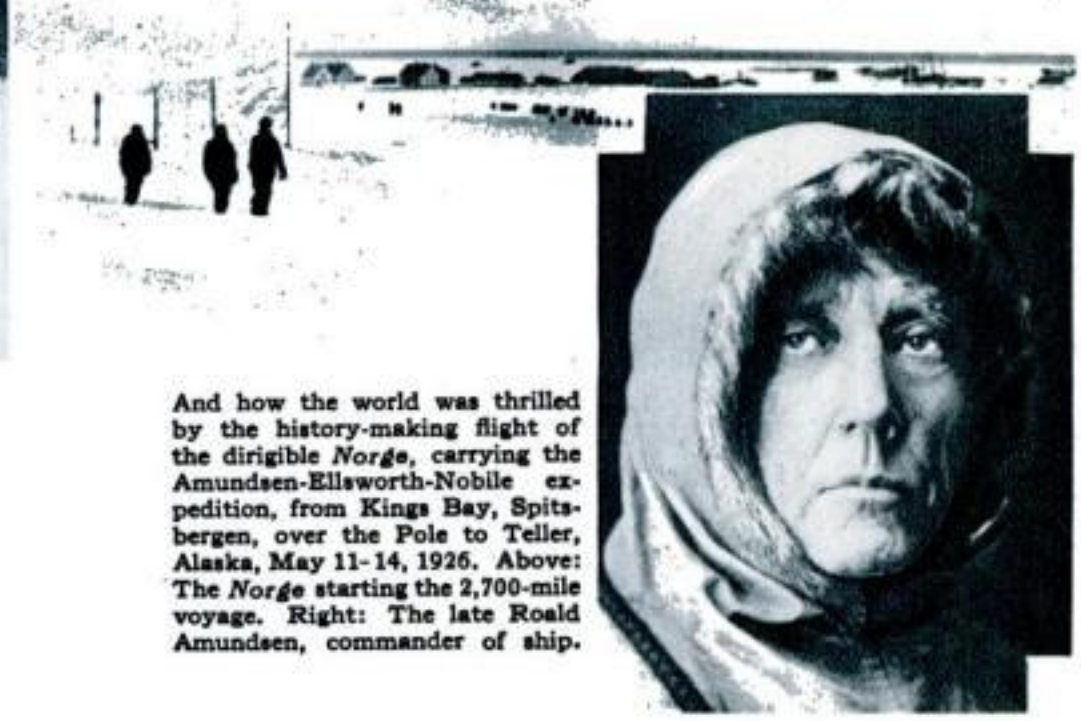
Flying boat in which the Spanish airmen, Commander Ramon Franco and Capt. Ruiz de Aida, blazed a 6,230-mile trail from Spain to Buenos Aires, Argentina, by way of Canary and Cape Verde Islands, in 1926.

Completing first round-trip England-Australia flight—Alan Cobham landing on the Thames River, October 1, 1926.

Delivered across the ocean—Uncle Sam's dirigible *Los Angeles*, formerly the *ZR-3*, landing at Lakehurst, N. J., after a flight of 5,066 miles from the Zeppelin works at Friedrichshafen, Germany, October 12-15, 1924. It carried 32 passengers on its nonstop flight of 81 hours and 17 minutes.

Across the U. S. in One Hop—The Army Flight around the World—England to Australia, and Spain to Buenos Aires

Who can forget that first daring airplane flight over the North Pole? Right: Monoplane *Josephine Ford*, piloted by Commander Richard E. Byrd and the late Floyd Bennett, leaving Spitsbergen for fifteen-hour hop to the Pole and return, May 9, 1926. Below: Roald Amundsen, famous Viking explorer, congratulating Byrd.



And how the world was thrilled by the history-making flight of the dirigible *Norge*, carrying the Amundsen-Ellsworth-Nobile expedition, from Kings Bay, Spitsbergen, over the Pole to Teller, Alaska, May 11-14, 1926. Above: The *Norge* starting the 2,700-mile voyage. Right: The late Roald Amundsen, commander of ship.

Army amphibian planes over tropical waters on U. S. Good Will tour through Latin America. Five planes, led by Maj. Herbert A. Dargue, left San Antonio, Tex., December 21, 1926. One crashed. Four flew 20,470 miles, arriving at Washington, D. C., May 2, 1927. Right: President Coolidge welcoming the flyers at Bolling Field.

Overshadowed but by no means eclipsed by Lindbergh's great hop to Paris was the record nonstop flight of Clarence D. Chamberlin from New York to Eisleben, Germany, in the monoplane *Columbia*. With Charles A. Levine as passenger, he started from Roosevelt Field, N. Y., June 4, 1927, and flew 3,911 miles in 42½ hours. Above: The *Columbia* nose down in a German swamp. At right: Chamberlin (left) and Levine before the start at Roosevelt Field.

The great story of Colonel Lindbergh and the first New York-Paris flight, May 20-21, 1927, was retold in pictures in last month's issue. Here is the *Spirit of St. Louis* flying from Belgium to England.

Air Pioneers Who Blazed the Long Trails—Lindbergh, Byrd, Chamberlin, Amundsen, and the U. S. Army Good Will Flyers

Trans-Atlantic passenger travel by airship really began with the great flight of the German dirigible *Graf Zeppelin* from Friedrichshafen, Germany, to Lakehurst, N. J., October 11–15, 1928. With a crew of forty, twenty passengers, and freight, she traveled 6,630 miles in 111 hours 46 minutes, though buffeted and damaged by storm. The photo shows the Zeppelin passing over New York.

First to fly the Atlantic westward in a single hop—from Africa to Brazil. Capt. Dieudonne Costes (left) and Joseph Lebrix, French aces, in Breguet biplane in which they made 35,000-mile flight around the world in 338 flying hours, starting and ending at Paris, October, 1927-April, 1928.

Lady Mary Bailey, British aviatrix, with daughters at Croydon airport, England, after a round-trip solo flight to Cape Town, Africa, starting March 9, 1928.

American air heroes who, up to the summer of 1927, had distinguished themselves in ocean flights, photographed after a reception by President Coolidge. They include Lindbergh, Chamberlin, Byrd, Balchen, Brock, Schlee, Ruth Elder, Haldeman, Levine, Maitland, and Hegenberger.

Westward across the Atlantic in an open cockpit biplane. The start of the 4,200-mile flight of Capt. Francisco Jimenez and Capt. Ignacio Iglesias, Spanish airmen, from Seville, Spain, to Bahia, Brazil, March, 1929.

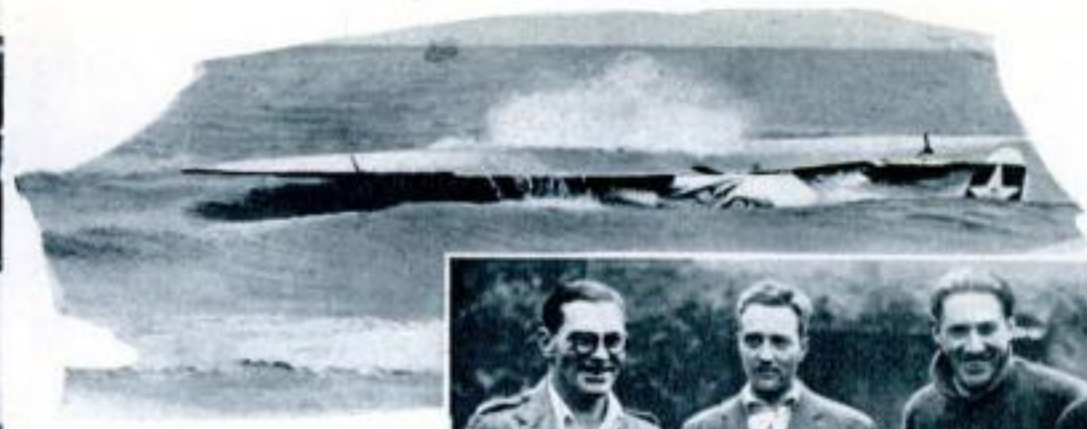
U. S. Army plane *Question Mark* refueling from "nurse ship" during record duration flight of 150 hours in California last January.

Jimenez and Iglesias, standing beside their plane at Seville before the start of the flight to Brazil. Loaded, the machine weighed 10,000 pounds. It was equipped with a 500-horsepower motor.

The Lockheed monoplane in which Capt. Frank M. Hawks set a cross-continent speed record of 18 hours, 21 minutes, 59 seconds, February 4-5, 1929. The plane flew about 2,700 miles at an average speed of 150 miles an hour. A special cowling around the Wright motor reduced air resistance and increased speed.

Graf Zeppelin's *Voyage to America*—*First Westward Atlantic Crossing by Airplane*—*Great Distance and Duration Flights*

Commander Francesco de Pinedo, Italian Royal Air Force, who flew 30,000 miles over four continents, February 13-June 16, 1927. His course: Rome-Africa-South America-United States-Newfoundland-Rome.



Commander Richard E. Byrd and crew of monoplane *America* after forced landing at Ver-Sur-Mer, France, in record four-passenger ocean flight from Roosevelt Field, N. Y., June 28-29, 1927. Left to right: Noville, Byrd, Acosta, Balchen. Above: Wreck of the *America* after flyers had missed Paris in fog.

First to make a nonstop flight over the Pacific to Hawaii—Lieut. Albert F. Hegenberger (left) and Lieut. Lester J. Maitland, U. S. Army Air Corps. In the tri-motored monoplane *The Bird of Paradise*, they completed the 2,407-mile hop from Oakland, Calif., to Honolulu in twenty-six hours, June 28-29, 1927.

Art Goebel, winner of the Dole race from Oakland, Calif., to Honolulu, Hawaii, August 16-17, 1927, and $25,000 prize. Time: 26 hours, 17½ minutes. Martin Jensen was the only other flyer to reach the goal. Of eight starting planes, four turned back and two were lost. The race cost ten lives.

The Bird of Paradise, Army transport plane, coming down to the landing field at Honolulu, Hawaii, after its nonstop flight over the ocean from California. It was the longest overwater flight attempted up to that time, and a triumph of skillful navigation. When the plane took off from Oakland, the load carried was 13,500 pounds—more than 6½ tons—of which 6,240 pounds was gasoline.

Monoplane *Woolaroc* in which Goebel won Dole race with Lt. William Davis, Jr., as navigator.

William S. Brock (left) and Edward F. Schlee, who flew 12,300 miles, Newfoundland to Japan, in an attempted round-the-world flight, August 27-September 14, 1927.

Colonel Lindbergh in *Spirit of St. Louis* arriving over Havana, Cuba, in his Good Will Tour of Central and South America. Between December 18, 1927, and February 13, 1928, he flew 9,060 miles over strange country.

The America's Thrilling Atlantic Flight — Over the Pacific to Hawaii — Pinedo's Amazing Feat — Lindbergh's Good Will Tour

First westward passage of North Atlantic by airplane. The German monoplane *Bremen* on Greenly Island, off Labrador, after 2,125-mile hop from Ireland, April 13, 1928. Right: The flyers, Capt. Hermann Koehl, Baron G. von Huenefeld, Col. James Fitzmaurice.

In this ski-equipped monoplane Capt. George H. Wilkins and Lieut. Carl B. Eielson made the first airplane flight across the Arctic Ocean, April 15-16, 1928. From Point Barrow, Alaska, they flew 2,200 miles to Spitsbergen in twenty hours and twenty minutes.

Amelia Earhart, first woman to cross the Atlantic by airplane, in the monoplane *Friendship*, after landing in Wales from Newfoundland, June 17-18, 1928. She flew with Wilmer Stultz, pilot, and Louis Gordon, mechanic.

Southern Cross flyers. Left to right: Lieut. Com. Lyon, navigator; Capt. Kingsford-Smith; Capt. Ulm, co-pilot; James Warner, radio man.

In one of the greatest of all flights, Capt. Charles E. Kingsford-Smith and three companions, in the tri-motored monoplane *Southern Cross*, spanned the Pacific for the first time, May 31-June 9, 1928. From Oakland, Calif., they flew 7,400 miles to Brisbane, Australia, in 83 hours, stopping at Honolulu and Fiji Islands en route.

Maj. Arturo Ferrarin (left) and Maj. Carlo del Prete (right), Italian pilots, made a record nonstop flight of 4,466 miles from Rome to Rouros, Brazil, in 51 hours, 59 minutes, July 3-5, 1928. Below: Their powerful monoplane.

An attempted westward trans-Atlantic flight that failed. The flying boat of Capt. Frank G. Courtney and three companions in mid-ocean after being forced down, August 2, 1928. All were rescued by steamer responding to S.O.S.

First Westward Atlantic Crossing — Wilkins' Great Hop Over the Arctic — Pacific Ocean Spanned by the Southern Cross

Are *You* Interested in Aviation?

DO YOU think POPULAR SCIENCE MONTHLY should run more aviation news, or less? The magazine is edited for its readers, and we have believed that a widespread general interest in aviation has justified the space we have given the subject. And yet here is a letter from a reader of long standing that surprised us:

"I AM one of your old readers—in two senses of the word. I have been reading POPULAR SCIENCE MONTHLY for a dozen years, and a month ago I passed my sixtieth milestone. Perhaps you will consider me a bit old-fashioned. Perhaps I am, for that matter, although I am still active in my profession, civil engineering, and last year was granted two patents in the automotive field, in which I have long been interested as a sort of avocation.

"I am prefacing this communication with these few statements so that you will not consider me hopelessly behind the times when I ask you whether you do not believe you are devoting entirely too much space to aviation.

"Most of your covers for the last year or so have pictured aviation subjects, and it has seemed to me that I could not turn two pages of any issue without encountering an aviation article of some kind. You have had air mail, air transportation routes, airports, the 'Fathers of Flight,' 'How I Learned to Fly,' and whatnot. Most of it is interesting reading, I will admit, but, don't you think, emphasized all out of proportion to the importance of the subject?

"Aviation today has scant relation, in my opinion, to science or utility. The air mail is uncertain, transportation by airplane, despite claims of promoters, virtually negligible; private ownership of airplanes is a joke. A few people have airplanes merely to attract attention and show their neighbors that they can afford them.

"I would not accept an airplane as a gift. I would not ride in one even if Lindbergh was the pilot, and I am certain the vast majority of sensible persons feel the same way. Although I am, and have been for forty years, engaged in a profession that can be classified as scientific, I have no interest in the so-called science of aerodynamics, which does not move, has scarcely advanced since its principles were established by the Wright brothers.

"You did print an article—by a British war pilot if I recall correctly—some time ago which considered these points. I applauded this at the time, for I believed at last you were on the right track, but in the very next issue you regained your membership in the aviation claque, and you have remained there ever since.

"I would not counsel you to banish aviation entirely from your magazine, but I would urge that you treat it in its proper relation to other things."—J. P. F., Chicago, Ill.

Fill Out This Coupon and Mail to the Editor

ALTHOUGH we do not agree with the gentleman, still we believe that his letter raises so many interesting points that it should be submitted to our readers to the end that we get a frank expression of opinion from them.

Are *you* interested in aviation? Have you flown, or would you like to fly? Do you own or are you planning to buy an airplane? Would you like to take a course in piloting as Larry Brent did? Would you use an airplane instead of a railroad train for a transcontinental journey? Would you like to see more or fewer articles in the magazine about the opportunities in aviation? Are you interested in the new types of planes developed from time to time and in the new engineering features of these planes?

These are just a few topics that our correspondent's letter suggests. Undoubtedly you have other ideas about aviation. Won't you write us a letter and express fully and frankly your views on the subject? Such letters are the editor's best guide in producing the type of magazine best suited to your needs.

If you are too busy to write a letter, you will help us by filling out the accompanying coupon and mailing it to The Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Underline, in each case, the word or words which convey your answer.

Dear Editor:

I believe POPULAR SCIENCE MONTHLY should publish more——less——aviation news.

I am interested particularly in:

1. New types of planes.
2. Learning to fly.
3. Getting into aviation
   - (a) as pilot.
   - (b) as aviation engineer.
   - (c) as mechanic.
   - (d) as a business.

I own——do not own——a plane. I am planning to buy——not planning to buy——an airplane for business——pleasure.

I use——do not use——an airplane for business transportation——for pleasure.

Name.....

Address.....

Age.....Occupation.....

Note: The foregoing is for the information and guidance of the editors of POPULAR SCIENCE MONTHLY and is given to them in confidence.

Mail to The Editor, POPULAR SCIENCE MONTHLY, *250 Fourth Ave., New York City.*

Little Black Bag to Solve Crimes

By H. C. DAVIS

Capt. William A. Jones, famous firearms expert, comparing the "fingerprints" on two bullets under a double microscope.

Characteristic marks of firing pin and breech block revealed that shells in top row were fired in a different gun from those at bottom.

Identifying a murderer's weapon. From bullet *B*, fired from suspected gun, a narrow strip was superimposed on murder bullet *A*. The markings matched.

A LITTLE black bag, twenty-two inches long and a foot high, and looking for all the world like the traveling case you take along on week-end trips, was recently presented to each of the detectives at police headquarters in New York City.

These bags, however, were not designed to hold pajamas, toothbrushes, and combs. They are portable miniature laboratories for use in the scientific detection of crime; an outfit devised by modern criminology to defeat the cunning of the evildoer and track him down.

There are a huge magnifying glass, a complete fingerprint set, including the vacuum gun for blowing powder, white or black, and the powders themselves; test tubes in which to preserve such telltale exhibits as hair or finger nails of victim or murderer; a searchlight capable of burning seven hours, a pair of rubber gloves, a trouble-finder, which is a lanyard bearing a flashlight; steel mirror, small saw, hammer, three chisels, pair of calipers, screw driver, pair of tweezers, tape measure, set of colored crayons, paper, twine, and stenographer's notebook.

DISTRIBUTION of the new tool kit marks the latest step in crime solution along scientific lines. The old-time "deduction" method, which depended largely upon the ingenuity and reasoning powers of the individual detective, is virtually a thing of the past. It has been superseded almost entirely by exact science and specialized knowledge.

One of the newest branches of scientific crime detection is "fingerprinting" bullets. As an example of the effective work done in this field, take a case solved recently in Maryland by Captain William A. Jones, famous New York firearms expert. A gun was left beside a murder victim to suggest suicide. Relatives suspected foul play and called in Captain Jones. When he examined the fatal lead and the gun, he found that the firearm had four grooves in the rifling inside the barrel, while the death-bullet had been fired from a weapon with six!

Experts in ballistics, as the scientific study of firearms is called, have discovered that every bullet is marked by the gun that shoots it and that no two guns are alike in this respect. First of all, the rifling varies. These spiral grooves within the barrel, which spin the bullet to keep it from somersaulting in its flight, twist to the right in some makes, and to the left in others. The number of these grooves varies from four to seven, and in some weapons they make a greater number of turns in a given distance than in others. A glance at a bullet will tell an expert what sort of barrel it passed through, and so narrow down the search for the weapon used in a killing.

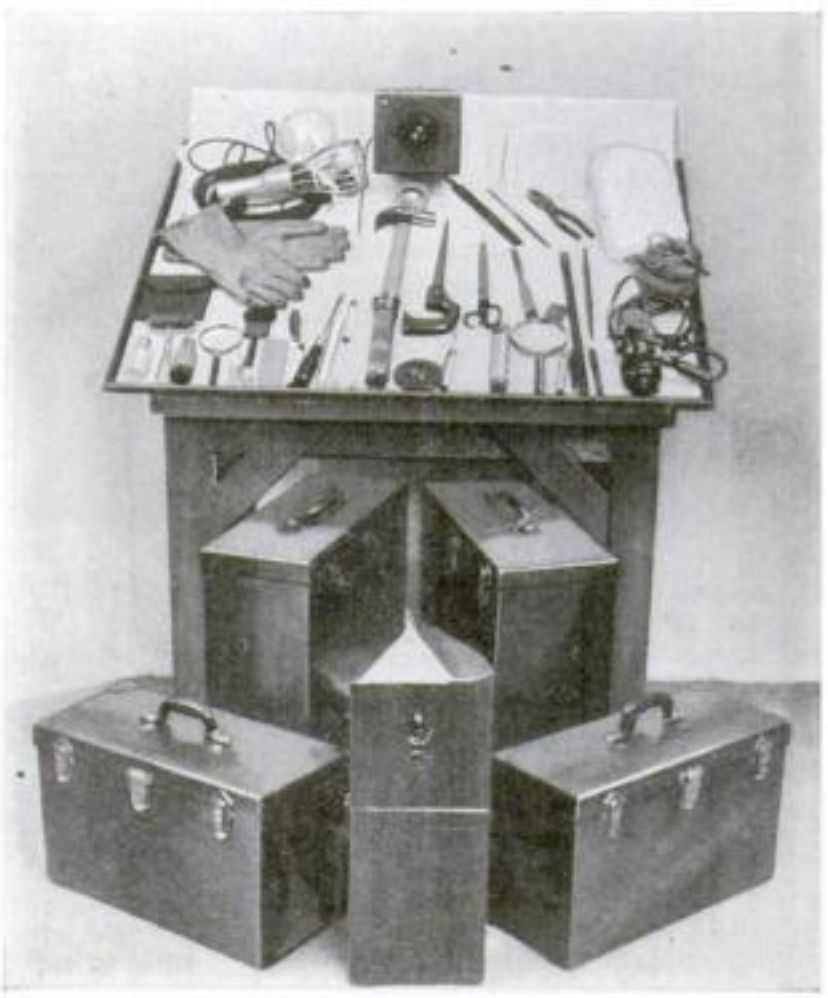
When a firing pin strikes the primer of a cartridge, it leaves a craterlike indentation. Frequently a peculiarity of the pin offers the expert a clue. Such was the case not long ago when a man was found dead by the roadside near Herkimer, N. Y. Both barrels of a shotgun had been emptied into his body and the two empty shells lay beside him. When examined, one shell was seen to have been exploded by an ordinary firing pin and the other by a triangular one! State police searched the neighborhood and brought in a gun in which one pin had been broken and replaced with a piece of metal that made a triangular dent. The owner confessed to the shooting.

Another noted arms expert, Major Calvin Goddard, some weeks ago sought to solve the St. Valentine's Day gang killings in Chicago and traced the fatal bullets apparently to the guns of gangsters already under arrest. So impressed were the Chicago police that four detectives were sent to New York for training in similar work. And the Chicago coroner, on the same occasion, declared:

"BALLISTICS and fingerprinting are now equally important in crime detection."

Speaking of fingerprints, the recording of the impressions of the thumbs of criminals as a means of identification was one of the earliest processes introduced to take the element of guessing out of crime detection. The fact that fingerprints never change during the life of the individual was discovered by J. E. Purkinje, a German physiologist, in 1823, and it was he who was largely responsible for their present classification. There are three principal types—loops, whorls, and arches. The fingers of about sixty percent of all people have markings of the loop variety, thirty-five percent have whorls, and five percent arches.

The Paris police force was the first to adopt fingerprinting. This it did in



Black kit bags recently issued to New York detectives. Each contains the scientific crime detection outfit spread on the table.

IN HIS revelation of the appalling crime "harvest" in America, President Hoover pointed out that "more than 9,000 human beings are lawlessly killed in the United States each year," and that "little more than half as many arrests follow." This article tells of remarkable detective methods developed by science to meet what the President termed the "dominant issue before the country."—The Editor.

J. A. Faurot, former New York deputy police commissioner, who introduced Bertillon system of identification to America.

1882 as part of the elaborate system of criminal identification invented by Alphonse Bertillon which, virtually unchanged, is used by the police of most countries today. Aside from making finger impressions, it includes taking measurements of various parts of the body and recording the color of the iris of the eye. Today files of the New York police department contain more than 500,000 fingerprints arranged so that a particular specimen may be found for purposes of comparison within five minutes!

THE number of sciences enlisted in the war upon enemies of society continually increases. Chemistry, microscopy, psychology, biology, and general medicine have figured conspicuously in famous criminal cases. More recently, Roentgenology—the scientific application of X-rays—geology, mineralogy, astronomy, ethnology, zoology, ornithology, botany, and even entomology, have proved invaluable aids to the detective, as have also metallurgy and various branches of technology, including specialized knowledge of ink, papers, cloths, hair, dyes, leather, foodstuffs, and other substances.

How chemistry, microscopy, and Roentgenology are used in the detection of fraudulent imitations of masterpieces of painting was described in POPULAR SCIENCE MONTHLY for May. Likewise, a knowledge of paleontology and geology have been employed to expose counterfeiters of prehistoric excavations.

A typical fingerprint in Faurot's collection. Millions of prints are on record, yet no two have been found identical.

Not long ago, geology was instrumental in solving a New York murder mystery. The remains of a woman's body, weighted down with pieces of stone, was washed up on the New Jersey shore of the Hudson River. Detectives at first assumed that the stones were pieces of the rocks found where the body was discovered, and hence that the crime had been committed in that neighborhood. Geologists of Columbia University, however, established that the stones were parts of the foliated rock on which portions of upper Manhattan are built. In this way the crime was traced to uptown New York, where the murderer had obtained the stones from a subway excavation. Capture and conviction of the criminal followed.

Entomology, bacteriology, and pathology a few years ago led to the solution of one of the most baffling murder mysteries in history. An elderly married man was found dead in bed in his home at Cape Town, South Africa. No marks of violence were found on the body, nor could physicians discover a "natural" cause of death.

Nine police photos of Paul Diamond—"the man of many faces." His cleverness in disguising himself was defeated by fingerprints.

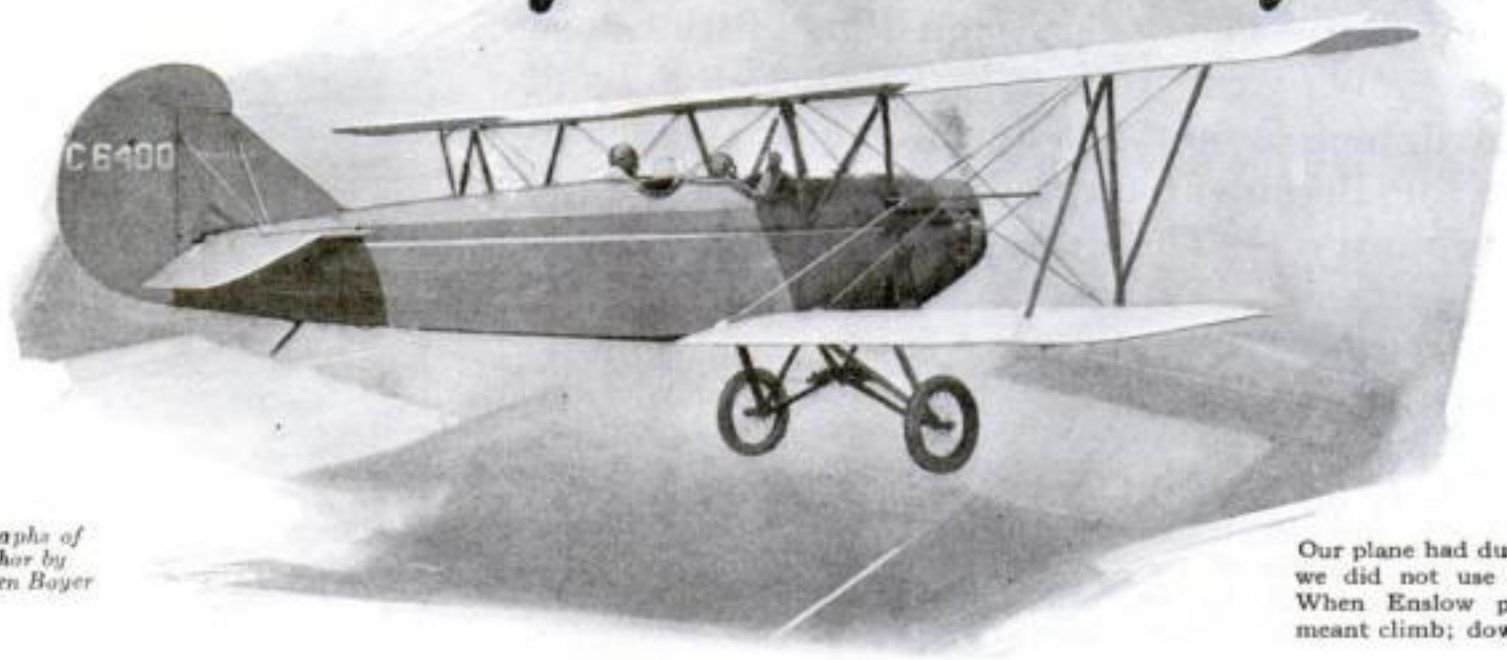
FINALLY, a specialist diagnosed it as nagana, or sleeping sickness. This only deepened the mystery, for the tsetse fly, the carrier of the fatal germs, is not native to Cape Town. Then a detective had an inspiration! A man who was a close friend of the young widow had recently returned from a trip to a region 700 miles distant. An entomologist was consulted, and he disclosed that the tsetse fly abounded in that particular part of the interior! Next, the movements of the friend were traced, and it was soon found that he had imported the deadly insects and introduced them under the mosquito netting of the old husband.

In many homicide cases chemists, by analyzing the remains of poison in the stomachs of victims, and of blood, drug, and acid stains on clothes, beds, rugs, and automobiles, have given invaluable aid in tracking down culprits. In cases of drowning, water from the lungs is examined for flora, fauna, and mud peculiar to certain regions.

A COUPLE of years ago, discovery by a chemist of partly digested sardines in what was left of the stomach of a rich California rancher who had been shot to death and then burned beyond recognition led to the solution of a crime that had been planned with diabolical ingenuity, and to the capture of the murderer. The slayer had put his own clothes on the body of the victim before cremating it, then had disappeared to create an impression of suicide. But before the murder, the two men had eaten at a hotel and the innkeeper, at the inquest, after recognizing bits of charred clothing as belonging to the murderer, testified that the man had had lunch at his place in company with a prosperous ranch owner who had ordered sardines!

Shortly afterward, similar methods aided in establishing the identity of a wife-murderer and causing his subsequent arrest. In a shallow grave dug hurriedly on the outskirts of New York City, the police found the body of a woman in such an advanced state of decomposition that recognition was impossible. The stomach was sent to a chemical laboratory and all that was found were a few grape seeds. Then the neighbor of a man in one of the suburbs, whose wife had disappeared mysteriously about a week previously, remembered having had dinner with her the evening before her disappearance. And they had eaten grapes for dessert! This at once fixed the identity of the dead woman, and it was but the work of a day or so to capture and grill the husband, who confessed.

Learn *to* Fly *with* Larry Brent



Photographs of the author by D. Warren Boyer

Our plane had duplicate controls, but we did not use the speaking tube. When Enslow pointed upward it meant climb; downward meant glide.

Whirling to Earth in a Sickening Tail Spin! How Does It Feel? You'll Know When You Read This Great Story

By LARRY BRENT

THE "deadly tail spin," if you will take my word for it, is every bit as terrifying, as sickening, as sensational, as deadly, as it is advertised. I have been in three spins; two voluntary spins and one into which I plunged against my will—because my sense of balance did not function quickly enough to save me.

These spins were part of my flying instruction. I asked for them. I wanted to learn how to pull a ship out of a tail spin. For years I had been reading newspaper accounts of flyers being killed. "His plane went into a tail spin, and he could not pull it out." Or, "It is believed that So-and-So went into a tail spin from which he could not extricate himself."

From the moment I started learning to fly it was in the back of my mind that, fairly early in my course, I would have my instructor show me how to pull a ship out of a spin. I wanted that lesson behind me before I took my first solo flight. Whenever it came into my mind, I asked my instructor when we would do some spins. I had had a little more than six hours of instruction when Randy Enslow, my instructor, said:

"YOUR air work has been improving. Your take-off is improving, too. And your landings are fair—as fair as we can expect at this stage. I think the time has come to show you how to get out of a spin."

I asked Enslow if he liked tail spins. He answered with one of those vague looks. A foolish question. No flyer likes spins.

We wore parachutes. Randy Enslow has twice had to make parachute jumps from planes to save his life. He mentioned these jumps one time when I asked him whether he thought it would be all right if I "bailed out" some morning just for the thrill of it.

Enslow has a way of looking at people who ask him silly questions. It is a look that does not have to be elaborated with words. His eyes go dull. His mouth goes slack. It is as though he were watching the antics of an imbecile. But this time he elaborated the look with fifteen words:

"The only times I used a parachute I would have been killed if I hadn't."

I HAD heard about one of those jumps. A salesman-demonstrator from one of the parachute companies gave us a lecture one morning in ground school. He showed us, in the classroom, just what happens when the rip cord is pulled—how the parachute spills out of its pack, and how the neatly stowed cords unfold. Then he showed us how a parachute is repacked—a laborious, delicate job. After his lecture and demonstration were over, he said to the ring of students and pilots surrounding him—there were at least thirty men in the crowd:

"My plane is outside. If any of you boys would like to go up and make a jump, today would be a perfect day for it. No wind. The ground is dry. Who would like to go up with me and make a jump? I mean, of course, it will be free."

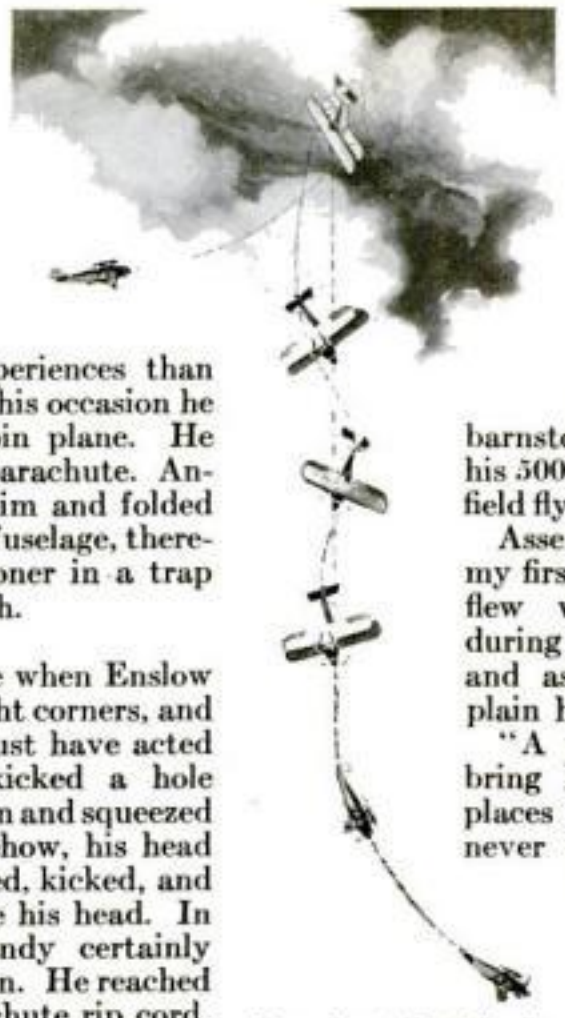
How many men, among them some dare-devils of the air, jumped at this chance? Not one! The circle of flyers and fledglings jeered and hooted. Jump out of a nice, safe plane? Not on your life!

Said one flyer: "When I see my wings breaking off and go floating by, then I'll jump."

Without a single exception, every flyer I have talked to has said the same thing.

No parachute jumps for them unless it is absolutely necessary.

Captain William—Bill—Purcell, who is in charge of the Curtiss Ground School, told us of oneof Randy Enslow's parachute jumping experiences. Enslow has had more hair-raising experiences than any flyer I have met. On this occasion he was flying alone in a cabin plane. He happened to be wearing a parachute. Another ship smashed into him and folded both wings back about the fuselage, thereby making Enslow a prisoner in a trap which was hurtling to earth.



In and out of a tail spin. Tail is up, not down as popularly believed, and revolving madly. The nose is revolving, too.

I HAVE been in a plane when Enslow pulled it out of some tight corners, and I know how quickly he must have acted on that occasion. He kicked a hole through the side of the cabin and squeezed out feet first. Then, somehow, his head became caught! He twisted, kicked, and wiggled, but could not free his head. In another few seconds, Randy certainly would have been a dead man. He reached down and pulled the parachute rip cord. The chute blossomed. Would it snap his head off—or pull him clear of the wreckage? It yanked his head out of the trap—and he floated to earth.

Among the old war flyers there was a saying, "Don't use up your luck." It meant, don't tempt fate by flying too long, because sooner or later you'll crash. Randy Enslow has "used up" more of both kinds of luck than any man I ever knew. He has been in more perilous positions—and had more miraculous, whole-skinned escapes.

Enslow and other veteran flyers insist that these escapes are seldom miraculous. They are the happy results of hundreds of hours of flying experience. The longer you fly, the safer you become, the readier is your brain to deal with split-second emergencies.

Lieutenant Arthur Phillips, a well-known Army flyer who, for a time, was an instructor at Curtiss Field, reduced this rule to figures. I asked him one time how long it would take a flyer to learn *everything* about flying. He answered:

"A man can be a good flyer and make a good living at flying without knowing everything. I recently made a survey among Army flyers, asking them how long it took a man to learn to fly perfectly. According to them, a flyer did not stop learning until he had flown about 1,200 hours. They agreed that, up to the 1,200th hour, a flyer seldom makes a cross-country trip without learning something new."

I THOUGHT that that estimate was too extreme until I made inquiries at the New York office of Pan American Airways. I wanted to know how much experience a flyer must have to join their pilot staff. I was informed that senior pilots (each Pan American ship carries two pilots) must have flown at least 2,000 hours; that junior pilots must have flown 1,500 hours.

Major Burtis Thomson, an Army flyer, put it this way to me:

"You will get into tight squeezes at 1,000 hours that will scare you green—because you wonder how you would have handled the same situation at your 200th or 500th hour."

Randy Enslow said: "It depends on how and where you pile up your hourage. A man who has done barnstorming is better at his 500th hour than a flying field flyer with 2,000 hours."

Assen Jordanoff, who was my first instructor and who flew with the Germans during the war, disagreed, and asked Enslow to explain himself. Enslow did.

"A barnstormer has to bring his ship down into places where a ship has never landed before—into fields in steep valleys sometimes, and into fields no larger than back yards. Every inch of the way down is new territory. You don't know what updrafts, downdrafts, or cross currents to expect. But you land your ship. And your next town will present an entirely different set of problems. A barnstormer *flies* his ship!"

"And makes nothing but side-slip landings," Jordanoff gibed. This may need explanation. Good pilots consider a straight glide a more workmanlike approach to a landing than a side-slip. Sometimes a side-slip landing is necessary, owing to the smallness of the field or wind conditions. But a pilot who gets into the habit of making side-slip landings is guilty of lazy flying.

"BARNSTORMERS," Enslow argued, "learn to land on a dime. And in barnstorming, you're taking off and landing every five minutes, in all kinds of weather, usually with a ship that should have been on the junk pile a year before. You learn to fly anything—anywhere—any time."

Enslow is a graduate of the barnstorming school. He and Lindbergh were barnstormers before Lindbergh went into the air mail. I am so convinced that barnstorming is the best way to learn flying that I am seriously considering going into it as soon as I have my limited commercial license. It is an excellent way to pile up hourage, and Enslow says there is still fair money to be picked up at it, in spite of the increasing number of airports with their resident flyers.

The old Army flyers' saying, "Don't use up your luck," was much more appropriate in the old days than it is now. Planes are so much safer than they used to be. There was a time when a pilot who found his ship in a tail spin had only one thing to do: pray for his soul. There was no hope for his body. In those days he wore no 'chute, and in those days a ship once in a spin stayed in the spin until it crashed.

MOST modern ships are engineered with such perfect stability that they must either be fought into a spin or they will, of their own accord, pull out of a spin. The most advanced of modern ships will almost fly themselves. Many of them you can fly "hands off" for minutes at a time, provided the air isn't too rough. I have been in a Ford-Stout loaded with twelve passengers when the pilot—I sat beside him—had his hands off the controls for almost five minutes. Many flyers believe that the time will soon come when, with gyroscopic stabilizers, a plane may be set on a course and will hold it without attention from the pilot for hours. It will do practically everything itself but take off and land.

The plane in which Enslow and I did the tail spins had duplicate controls. We did not use the speaking tube. In fact, we had been using it less and less lately. A gesture to the right or left meant a right or left turn; a thumb jabbed upward meant climb; downward meant glide. If I wanted to attract his attention, I flapped the ailerons or wabbled the rudder

After it was all over, Enslow gave my shoulder a fatherly slap, and said: "Don't worry, kid, you're going to make a flyer."

I asked Enslow as we walked over to the ship that morning if he liked tail spins. He answered with one of those vague looks. I had asked a foolish question. No flyers, with the possible exception of the stunt men who are a law unto themselves, like tail spins. The spin has a bad reputation. As far as I am concerned, it deserves a much worse reputation.

Enslow helping me into parachute harness. The chute is neatly packed in the seat-cushion bag.

I CLIMBED our ship that morning until the altimeter read 2,500 feet. Then Enslow took the controls, cut the motor, and shouted: "Hey—safety belt?" Mine was securely buckled. I nodded. He climbed to about 3,000 feet. Again he cut the gun and shouted: "Hey—a loop!" The nose went down. The speed of the motor increased audibly. Back came the duplicate control stick between my knees. Up went the nose. The horizon dropped out of sight. I was then conscious of a sensation as if my brains were rushing to the front of my skull. The safety belt pulled against my waist. Looking straight up, I saw the ground flashing by. Then the horizon came back to where it belonged.

Enslow did other stunts—wing overs, vertical banks, side slips, a roll out of another loop—trying out the ship's responsiveness. He climbed to 4,000 feet and cut the gun. He shouted above the singing of the wires:

"Hey!—*Spin!* Hang on, kid!"

HE PULLED the nose up almost straight into the sky, then threw her over on the left wing—and we were in it! I want to say again that everything bad I have ever heard about the tail spin has been an understatement. The terror of the tail spin simply cannot be exaggerated. But I wish to correct one popular misconception. A tail spin does not mean that a ship is spinning toward earth tail down. The tail is up—way up—and revolving madly. The nose is also revolving madly, but pointing straight down. In that spinning condition, the ship plunges toward earth.

A spin starts loosely—that is, with tail and nose describing fairly large circles. Then the spin begins to "tighten up"; the circles cut by the revolving nose and tail grow smaller and smaller.

The ground was reeling, spinning, whirling. Unless you have been in a tail spin, nothing I can say will help your imagination to grasp how rapidly and in how many directions the ground was whirling. In tight turns, I have seen the horizon go past the nose of my ship at 1,200 miles a minute! A good reporter might be able to describe his sensations during a spin. I cannot. There was only the sensation of that horrible whirling and the sound of screaming wires as we shot toward earth. From start to finish, it lasted only five or six seconds.

Suddenly the ground ceased whirling. We were in a straight dive. I glanced at my altimeter. It had read 4,000 at the beginning of the spin. It now read 2,800. We had lost 1,200 feet. We lost another 200 feet in the dive, then Randy pulled her out of it. He cut the motor long enough to shout: "Hey! Grab her! Climb!"

I took the controls and climbed. I felt a little uneasy in the vicinity of my breakfast. I have made references to my stomach in previous articles—how it shrank and protested the first time I took the controls. But more and more recently it had become "air minded." Now it was back at its old tricks—shrinking, quivering, objecting to the prolonged insult of that spinning dive toward earth. My hand on the stick was none too steady. This time I was to put her into the spin; and this time I was to pull her out of the spin. Could I do it?

I kept my eye on the altimeter. The needle crept from 3,000 to 3,500. When it reached 4,000, Randy cut the motor.

"Hey! Spin her!"

I spun her. I did what he had done. I pulled back the stick until the nose was well up. The moment she stalled, I cut the gun and pushed the stick to the left. The left wing went over and down. The nose swooped down. Click! Snap! Who-o-oosh! We were in the spin!

IT HAD been so easy! Some ships, I have said, must be fought into a spin. Time after time, you pull up the nose until you stall, then push the left or right wing over. And time after time, the ship will slip out of that position into a straight dive—but not a spin. And once that type of ship is in a spin, it is just about as hard to get her out. You fight them in and you fight them out—and sometimes you cannot fight them out in time! Then the newspapers have another piece of bad flying news to spread all over the front page.

The ship we were flying that day went into a spin almost too easily. It snapped into it.

And again we were plunging down, tail up, and the earth was a horrible swimming confusion. And suddenly I could understand why students freeze onto the controls in tail spins. To pull out of the spin you must do exactly the opposite of what your common sense tells you to do.

You are diving straight down at the earth, aren't you? And to pull out of a dive, you pull your stick back, don't you? Yes—to both questions. But to pull out of a spin, you do not pull the stick back. You gently push it forward! At the same time you kick your rudder and hold it against the direction of the spin.

Randy showed me how to pull the rip cord to release the parachute. With right hand, grab a ring at your left side, and yank. Right: Hooking the last strap.

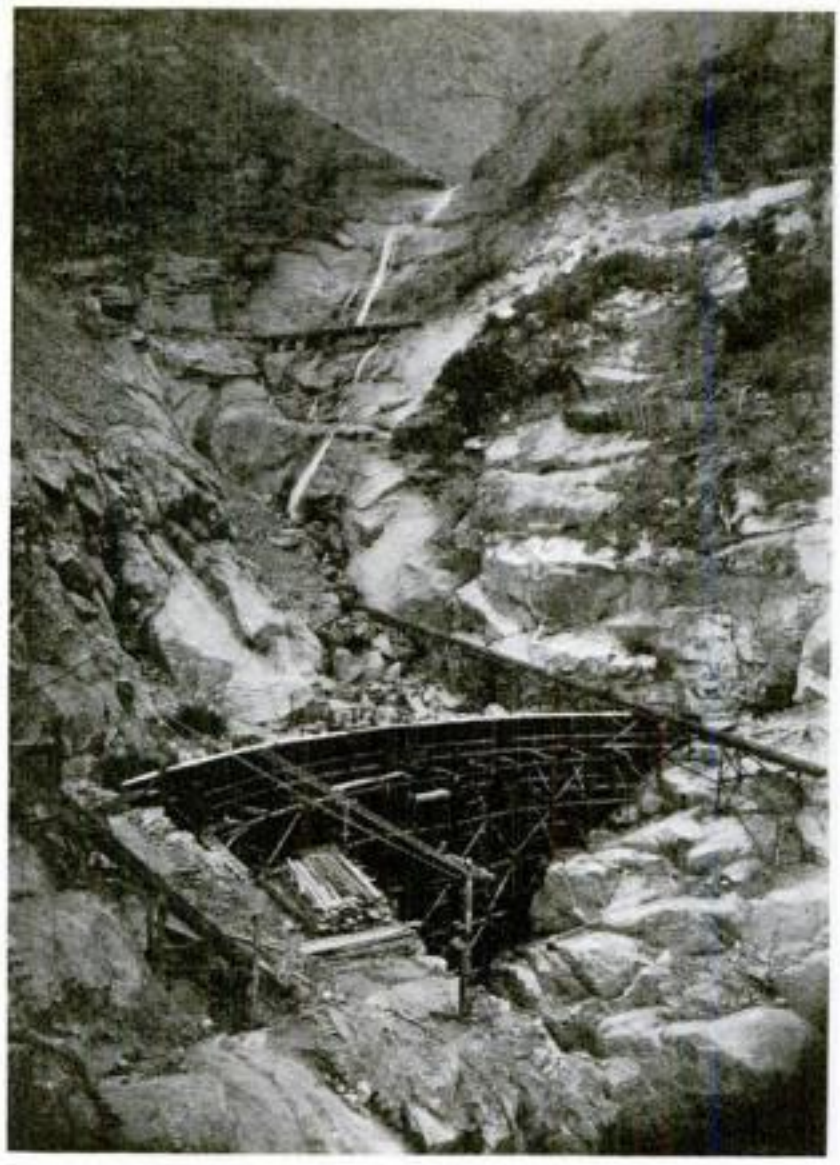
A side-slip landing, illustrated here, sometimes is necessary where the field is too small for a straight glide landing.

IT WAS probable that Randy Enslow had the pyrene in his hand, ready to slug me on the head if I made the wrong maneuver. Many a time has the fire extinguisher been used on a frozen student in a spin. I want to say again that instructors are among the greatest unsung heroes of the air.

But I kept my head, and presently we were no longer spinning. We were in a straight dive. It was then that I went into my third spin, the one I had no intention of going into. Although we were in a straight dive, the universe was still reeling. I pulled out of the dive. In doing so, I pulled out too far. Up went the nose, over went the right wing—and down we went in another spin—a reverse spin!

I had heard about these reverse spins—how students, even trained flyers, are (*Continued on page 134*)

Dr. Fredrik Vogt with scale model of Stevenson Creek experimental dam. It was made of materials taken from the site of the actual structure, which is pictured at right.



The Stevenson Creek experimental dam, built by Engineering Foundation near Fresno, Calif., to determine strength of walls.

Toy Dams to Save Lives

By ARTHUR A. STUART

IN A basement room at the University of Colorado, Boulder, is a laboratory unlike any other in the world. There engineers build and break little dams —exact replicas in miniature of the mighty water barriers of western states. From these scientific toys they are able to calculate accurately the capacities of the real dams and to safeguard the lives and property of valley-dwellers in irrigated regions.

A noted association of research engineers, the Engineering Foundation, with headquarters in New York City, in conjunction with the U. S. Bureau of Reclamation, is conducting the tests. So successful have they proved that the Foundation predicts that models and mathematics will go hand in hand in planning all future dams, and the Bureau, not long ago, set aside a fund of $20,000 to carry on the work.

In the past, model dams of rubber and of celluloid have been used in tests. The diminutive barriers of the Boulder laboratory, however, are made of the same material that goes into the large structures. Dirt and bits of rock have been transported as far as a thousand miles for this purpose. Not only is the material in the model similar to that in the real dam, but hundreds of painstaking measurements insure that the model is built exactly to scale.

WHEN the little arched walls are completed, miniature floods of heavy mercury, or water contained in rubber bags, press against the "upstream" face in a testing pit. Against the "downstream" face, a battery of needle-pointed rods, connected to delicate recording instruments, touch the surface and measure the slightest bulge. Even closer watch is kept upon deflections in the model by an amazing instrument, an optical strain gage which notes variations down to one millionth of an inch!

The first model made at the Boulder laboratory was a scale reproduction of an experimental dam built, not long ago, by the Engineering Foundation in a wild ravine in the mountains near Fresno, Calif. Known as the Stevenson Creek Dam, it was designed to see how thin a sixty-foot-high arch dam could safely be made. Only two feet thick, it showed surprising strength, holding back water that rose until it overflowed the top.

The model of this dam, made on a scale of an inch to a foot, underwent 250 load tests before it broke. A scale replica of the Gibson Dam, a Reclamation project on the Sun River, west of Great Falls, Mont., is now under test in the unique Colorado "proving ground."

ONE of the experts experimenting with the models is Dr. Fredrik Vogt, of the Norwegian Institute of Technology. Before coming to America, he made elaborate tests of the weak points of different-shaped dams, by molding models of rubber, similar to that used in erasers.

At Princeton University, New Jersey, Professor George E. Beggs is noted for a series of models made of celluloid. A remarkable one-fortieth-size reproduction of the Stevenson Creek structure indicated capacities that almost exactly tallied with the results obtained from the finished dam.

At present, Professor Beggs is at work upon two models of this sixty-foot dam as it would appear if it were eighty feet and a hundred feet high, respectively. Tests upon them are expected to reveal to what height the thin concrete wall could be built before it would give way under the terrific strain of water piling up behind it. The cost of determining this by increasing the dam's height would be more than $50,000.

Knowledge gained from tests of this kind is proving valuable in two great projects now under way. A concrete dam that will be a foot higher than the present record-holder, the Pacoima Canyon structure of southern California, described in the May POPULAR SCIENCE MONTHLY, is being built on the Skagit River in the state of Washington. When completed next spring, it will stand 386 feet high and form the heart of a $30,000,000 hydroelectric project under construction by the city of Seattle. The neighboring state of Oregon will soon eclipse this record. On the Owyhee River, the Government is building a gigantic wall of concrete to rise 405 feet when finished.

A dam at Lawrence, Kan., giving way before the rushing flood waters of the Kaw River. It is to prevent such disasters that the tests described here are devised.

Back of the Month's News

By

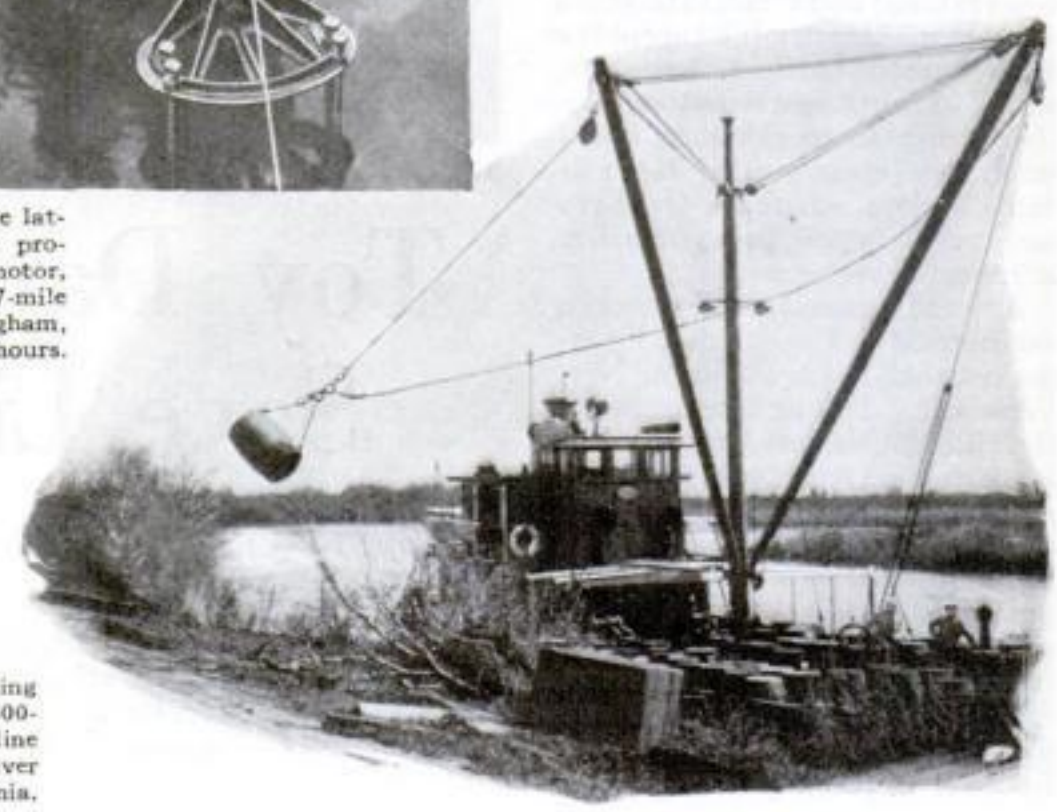
KARL VOOGHT

A NEW type of canal barge, the motive power of which is supplied by a detachable outboard gasoline motor instead of by the old-time horse or mule, docked at London, England, the other day after a successful 147-mile run from Birmingham. The 1929 model barge has an electric klaxon horn and headlight. A distant cousin of this craft was put into service recently along the waterways of the 600,000-acre delta section of northern California. It is the world's first floating filling station—a steel tanker designed to supply the gasoline and lubricating oil needs of the farms of that district, which can be reached only by waterways.

The appearance of the motor-driven barge would indicate that the train, the motor truck, and the commercial airplane have not yet made the canal obsolete as a means of transportation.

Although, in this country at least, most freight is shipped by train and truck, the great canals are still extensively used for leisurely and inexpensive transmission of goods. As recently as 1903, a sum of $101,000,000 to rebuild the Erie Canal so it might accommodate barges of 1,000-ton capacity and more was authorized by popular vote of the citizens of New York State! And as late as 1914, the Cape Cod Canal from Barnstable Bay to Buzzard's Bay, Mass., was opened, cutting off 100 miles and the most dangerous portion of the passage between New York and Boston. The Chesapeake and Ohio Canal, the Illinois and Michigan Canal, and the Illinois and Mississippi Canal, to mention only a few, also are still largely used.

Good-by mules! The latest in canal boats, propelled by outboard motor, in London after 147-mile run from Birmingham, England, in fifty hours.



The first floating "filling station" delivering 500-pound drum of gasoline for farmers on a river in northern California.

THE first American canal was dug in Orange County, N. Y., in 1750, for the transportation of stones. Work on the first real lock canal was not started until 41 years later. This was the Union Canal, from the Schuylkill River, near Reading, Pa., to Middletown on the Susquehanna River, which was finished in 1827.

George Washington was the father of a plan for a great interstate system of canals, to connect the Great Lakes with the Atlantic. His original scheme to extend the Chesapeake and Ohio Canal to Pittsburgh and from there to Ashtabula at Lake Erie was postponed on account of the tremendous cost. Had it been carried out, Baltimore, Md., might have grown to the size and the importance of New York City.

The Erie Canal, connecting New York with Lake Erie, was opened from Buffalo to Albany in 1825 with a total length of 325 miles. It reduced the time of transportation over this route from twenty to ten days and freight rates from $100 to $3 a ton! Incidentally, it will be remembered that President Garfield, when a boy, drove mules hauling barges along the Erie Canal.

Vacuum Tube a Mile Long

DR. ALBERT A. MICHELSON, distinguished University of Chicago physicist, whose measurements of the velocity of light are accepted as the last word on the subject, recently announced his intention of reducing or possibly eliminating the slightest error in his previous figures by making the amazing new test of reflecting a beam of light ten times back and forth through a vacuum tube a mile long!

That light travels with a speed of about 186,000 miles a second was discovered through observations during eclipses of Jupiter's moons by the Danish astronomer Olaus Römer as early as 1675. Until that time it was believed that light required no time at all to pass from its source to the observer. Later the famous physicists, Fizeau and Foucault, devised mechanical methods of making accurate measurements of the speed of light.

DR. MICHELSON, who is now seventy-six years old, began his studies in this field in 1880, when he found that the velocity of light was 186,360 miles a second. These tests he repeated in 1883 with the aid of Professor Morley principally to prove the existence of ether, considered a necessary medium for the transmission of light waves. It was upon the negative results of these tests that Einstein based his original relativity theory, in which the existence of the ether is denied.

In 1926, Dr. Michelson corrected his earlier findings and placed the velocity of light at 186,284 miles a second. This figure he reached after an ingenious experiment on top of Mt. Wilson in California. Here he set up a powerful arc lamp and a rotating octagonal mirror, an adaptation of the method used by Foucault. The latter apparatus worked like a spinning top of eight-sided shape with a mirror in each of its eight faces. On another mountain, twenty-two miles away—San Antonio Peak—he placed a stationary mirror. A ray of light directed on the rotating mirror from the arc lamp was shot across to San Antonio Peak, where mirror No. 2 promptly cast it back to the rotating mirror on Mt. Wilson. Knowing the speed of his spinning mirror, Professor Michelson thus was enabled to calculate the fraction of a second it had taken the light to travel the forty-four miles from Mt. Wilson to San Antonio Peak and back. In round numbers, the trip took 1/4,200 of one second!

THE mind can scarcely conceive this terrific speed. In the time it takes you to blink your eye light travels fast enough to go around the earth—25,000

miles—seven times. Yet this distance is so small compared to interstellar spaces that the light now reaching earth from the nearest fixed star, Alpha Centauri, started almost four and a half years ago!

Following his 1926 experiment, Dr. Michelson said that it had made possible the measuring of light velocity with only one mile of error a second! Close as this was, the scientist was not satisfied. He knew he could obtain even greater accuracy by increasing the length of the path over which the light is made to travel. So last year, he repeated the test, attempting to send the light from Mt. Wilson to a peak about 100 miles away and back. However, the air was not sufficiently clear to obtain a satisfactory image and the experiment was abandoned. It was then that Professor Michelson determined to devise a new test, which would eliminate such factors as temperature, humidity, and air pressure. Hence, the vacuum tube!

Refine Ore with Thunderbolts

A MAN-MADE thunderbolt of 3,000,000 volts, hurled across a thirteen-foot gap, recently was put to work refining ores by a California mining company. When Hector M. Hassell, inventor of the lightning machine, throws the switch, a giant tongue of fire and death streaks through the air, its unleashed power destroying life and disintegrating solutions in its path.

This spectacular experiment of separating mineral solutions by means of harnessed lightning interests us all. It suggests again the possibility that future scientific Joves may hurl their superbolts to smash atoms and realize the dream of the Middle Ages, the transmutation of metals, or send their giant sparks as "death rays" in time of war to blow up battleships or wipe out cities.

About five years ago, an Englishman, H. Grindell Matthews, arrived in this country with the claim that he had perfected such a death ray. He showed moving pictures of his device killing instantly an animal sixty-five feet away and blowing up a motorcycle. He said that by increasing the power he could bring down planes from the sky or stun the populations of cities so they could be easily taken in time of war.

ON HIS return to England, he announced that he had disposed of his invention to an American concern, but nothing has been heard of it since.

During the World War, a report was circulated that a German had invented an electrical ray that could short-circuit the motors of planes flying overhead. It was never confirmed.

Three-million-volt thunderbolt machine, exhibited by John T. Martin, president of the California mining company which is putting its harnessed lightning to work refining ores. Left: A photo of the tongued streaks of man-made lightning discharged by the apparatus.

High tension electricity has been applied before — usually in voltages under sixty thousand—to breaking down chemical solutions into their various elements. In the laboratories of the Carnegie Institution, in Washington, D. C., and of the General Electric Company, in Pittsfield, Mass., 5,000,000-volt "guns" recently gave awe-inspiring exhibitions of their power. Whether these thunderbolts of the laboratory will ever burst open the atom and allow science to create metals at will is a fascinating conjecture which only time can answer.

Cleaning the Air of Dust

IN THE trillion cubic feet of air which New York City's inhabitants breathe, there are 2,100 tons of dust—on a clear day! This staggering quantity is enough to cover an area the length and width of a city block with a pile high enough everywhere to bury a man standing upright. When the wind blows, even more dust is stirred up, according to Prof. H. H. Sheldon, of New York University, who declares these the first definite figures ever obtained on the actual amount of dust in the city's air.

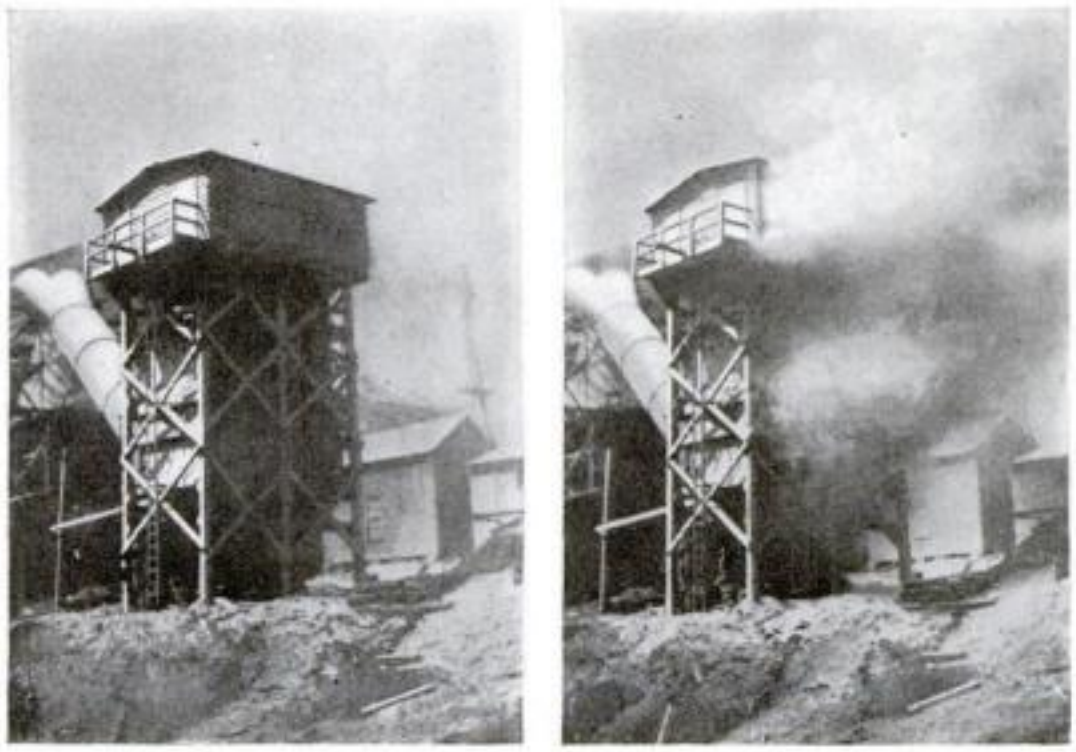
FOR centuries the pollution of air in great industrial centers has been recognized as an evil. Perhaps the first recorded protest against it was that of Queen Eleanor of England, who in 1257 refused to live longer at Nottingham Castle because of obnoxious black smoke from the village below. She went off in a huff to live at Tutbury Castle. Edward the First of England, in 1307, issued a proclamation prohibiting coal burning in London because of the "sulferous smoke and savour of the firing." It is said one man was hanged for persisting in burning coal.

If smoky-chimney offenders are less summarily dealt with today, it is not because their offense is minimized. Dust alone is a prolific source of asthma, medical authorities say; but probably its greatest danger is as a carrier of disease germs, of which countless numbers may ride on a single dust particle. A test plate exposed for five minutes in a typical New York apartment after sweeping collected 2,700 bacteria, as compared with 225 in a model hospital. Another source of danger from dust is that it screens out the ultra-violet health rays from sunshine.

WHAT is dust? Usually minute particles of soot, fibers, vegetable matter, molds, varying in size from the cinder that gets in your eye to particles so minute that they may remain in the air, wind-borne, for as long as two years!

What can be done about it? The first step, which health departments of many cities are taking, is to see that stoking of boilers and furnaces is done intelligently, to prevent excessive smoke. An air-cleaning campaign of this kind conducted by the U. S. Bureau of Mines resulted in a ninety-five percent reduction of soot in the business section of Salt Lake City.

Prof. Sheldon foresees that it may be necessary to install in apartment house chimneys electric devices to abstract the soot from outgoing gases. Such "electric precipitators" are based on the discovery of Dr. F. G. Cottrell, of the University of California, that metal plates highly charged with as much as 600,000 volts of electricity will gather solid particles suspended in air or gases. Smelters



Two photos of a slate grinding mill, illustrating effectiveness of electric "precipitator" in preventing dust. They show the dust collector working and not working.

have installed them as a boon to farmers in the neighborhood, whose fields were formerly ruined by soot and fumes; and they have been applied to dust removal in cement and slate milling plants, tar removal in gas manufacture, and the recovery of precious metals that otherwise would go up the flues in refining plants.

A Poor Shot Led to Tinless Tin Cans

A LAZY helper tossed a box of chemicals. It landed with a plop in a 100-pound pot of molten aluminum. Thus was born a secret alloy. Now, with the recent invention by its discoverers of a way to electroplate it on iron, it may revolutionize at least one major industry.

"Tinless tin cans" for food and tobacco, made of the cheap new alloy, are said to threaten the long-held supremacy of the old-fashioned tin can. Other uses are seen for the alloy in airplane metal, and as a substitute for expensive chromium plating on auto radiators and bath fixtures.

These fascinating vistas are opened by the discovery within the last year of a way to plate the alloy. But for eight years it has awaited use. Its romantic story starts in a Chicago workshop where its co-discoverers, Major A. Messlein and Edward L. Girard, Chicago engineers, were preparing a "melt" of aluminum to make a light engine.

A 100-pound pot of molten aluminum stood in the room. Girard called to a small colored boy, a helper, to pass him a wooden box, filled with assorted chemicals, to modify the batch. Instead, the boy tossed the box to another assistant who was nearer. He missed the catch. Into the pot of aluminum went box, chemicals, and all. "Seventy-five dollars gone!" Girard exclaimed, looking ruefully at where the chemicals had vanished in the "spoiled" batch.

BUT it wasn't spoiled! Fragments of the metal that had slopped over the side of the pot and solidified behaved less like aluminum than any metal the experimenters had ever seen. Tests of samples proved it was more like steel in strength. It had two other important features; it didn't tarnish or corrode, and, unlike aluminum, it could be soldered—a necessity, for instance, in can-making.

Could they duplicate the lucky accident that gave them the mixture? Luckily the experimenters knew what was in the box, and were thus able to produce the alloy intentionally. For it defied analysis! Prominent chemists, and even the U. S. Bureau of Standards, Girard says, could not tell them what was in it. Chemists of rival corporations, who might have given much to know of an aluminum alloy as strong as steel, confessed they could not detect the mystery metal's ingredients.

The experimenters freely gave away samples of the secret alloy—a silvery, light metal. It contained, they readily admitted, ninety-five percent of aluminum—and four other vital and secret ingredients. Try to find them!

They knew that if they could find a way to plate the alloy upon iron they would have a valuable substitute for tin. However, prominent chemists assured them—for a fee—that it was impossible, first to plate an alloy at all, second, to plate anything containing aluminum, and, third, to plate anything but copper with electricity upon iron, to which tin is applied in the manufacture of tin cans. Notwithstanding, Messlein set to work and eventually succeeded by himself, Girard

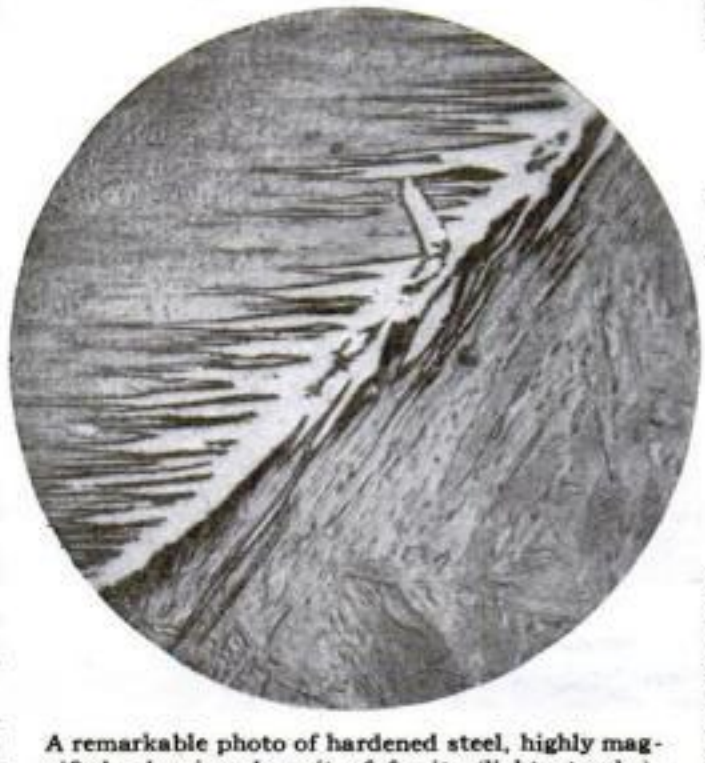
Machine used in the remarkable process of electroplating the new secret alloy on iron.

says, in performing all three of the "impossible" feats. He plated his alloy on iron. The first of several plants which will use the new process is now operating. Sample cans made with the new metal have shown no deterioration nor injured food placed in them for test, Girard says.

Why Metals Grow Tired

A BRIDGE in New Jersey recently collapsed for no apparent reason. Its beams, girders, and other steel parts appeared to be in excellent condition and gave no warning of the impending crash. Following an investigation the most acceptable theory was that metal fatigue caused the catastrophe.

Metals get tired, just as animals do; there is no way of preventing it except by resting the metal. That is the astonishing statement of Prof. J. B. Kommers, of the University of Wisconsin. When metal gets tired, it may break—sometimes at a wholly unexpected moment. A motor bus that carries forty passengers in the rush hour may wait until it is returning to the garage late at night to snap an axle. It seems as if minor jars, repeated many times, are more likely to make metal break than a few rude shocks. For some seventy years, metallurgists have been trying to find out why.



A remarkable photo of hardened steel, highly magnified, showing deposit of ferrite (light streaks). Such deposits may cause fatigue of the metal.

GERMAN experts tackled the problem first, but without conclusive results. Then Prof. H. F. Moore, of the University of Illinois, devised a way to subject metals to 100,000,000 shocks in the laboratory to observe its behavior. From microscopic examinations during the tests it appeared that metal failure starts when one of the microscopic steel crystals that compose it is cloven in two by local pressure and its broken parts, seen as separated by a line across the crystal, slip upon each other. When the shocks are continued the slipping spreads to other crystals and widens into a definite crack. Then the piece breaks.

Later tests showed that local stresses causing fatigue are intensified when the metal is not of uniform structure. And this may not necessarily mean flaws are present; for there are a number of different varieties of crystallized steel, such as pearlite, ferrite, and austenite, of which a single fragment of metal may be composed. Remarkable high-power photomicrographs recently obtained by the Bell Telephone Laboratories show vividly the streaks of different steels which may cause fractures to start. Corrosion may also result in fatigue and breaking, says R. J. McKay, New York metallurgist.

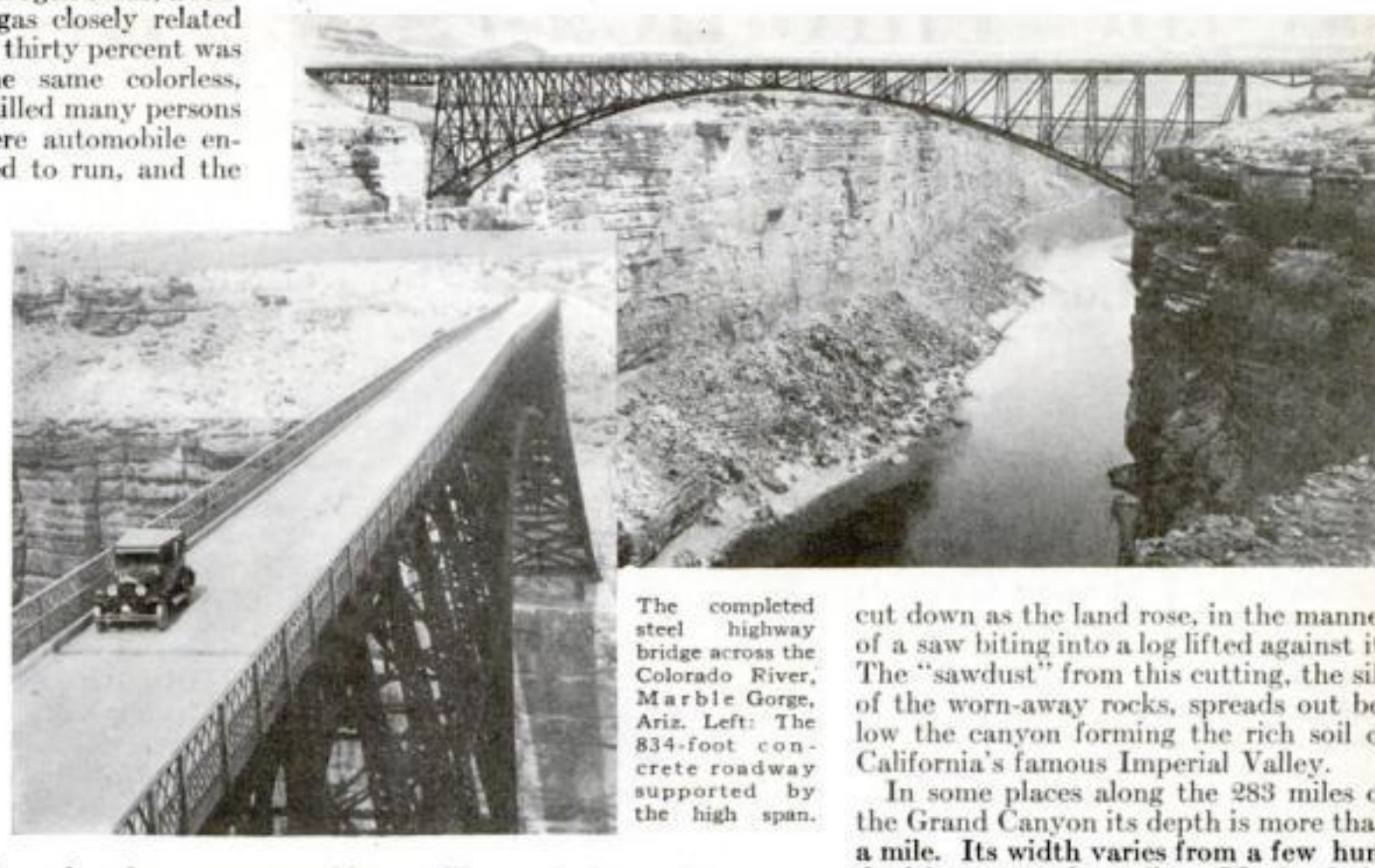
While the mystery of "fatigue" in metals is gradually being cleared up, practical tests meanwhile help to remove its menace. In the University of Illinois engineering laboratory, tests have been developed that, in a few days, subject a metal part to as much wear as it would normally receive in a lifetime. Another safeguard is a method of X-ray examination developed at the Massachusetts Institute of Technology that reveals flaws before they become dangerous.

Facts about Poison Gas in Cleveland Tragedy

HOSPITAL patients and heroic physicians and nurses who sought to rescue them—123 persons in all—were killed by poisonous fumes from burning X-ray films that exploded in a basement storage room of the Cleveland Clinic Foundation some weeks ago. In addition to these victims, at least fifty more were made severely ill.

Although its heavy death toll deeply shocked the nation, the disaster might have been much more appalling in its results. Experts who have since investigated its causes state that the 75,000 pieces of burning nitrate photographic film generated about 1,000,000 cubic feet of gas, enough to kill 4,000,000 persons—the population of greater Chicago!

About thirty percent of the deadly gas, the experts say, was nitrogen oxide, a reddish-brown corrosive gas closely related to nitric acid; another thirty percent was carbon monoxide, the same colorless, odorless gas that has killed many persons in closed garages where automobile engines had been allowed to run, and the remaining forty percent was harmless. The fatal effect of large quantities of nitrogen oxide or carbon monoxide may be imagined by realizing that one part of either in 100 parts of air is deadly! So strong were the poisons that coroner's assistants, performing autopsies at the morgue, were overcome by the fumes arising from the victims' bodies.



The completed steel highway bridge across the Colorado River, Marble Gorge, Ariz. Left: The 834-foot concrete roadway supported by the high span.

WHILE most of the victims died as a result of inhaling nitrogen oxide and carbon monoxide, analyses of the blood of others showed the effects of hydrocyanic acid and bromine gas. This indicated that different chemical conditions were created at the same instant in various portions of the four-story building.

What really happened was that the clinic, from cellar to roof, until that blew off, was converted in about half a minute into one gigantic chemical retort, with many chemical reactions going on at once, unstable organic compounds building up and breaking down in quick succession. These fatal chemical reactions occurred in rooms and corridors, and even in the lungs and bloodstreams of persons inhaling the gases.

THE cellulose nitrate of which the X-ray films were made is virtually identical in composition with smokeless powder. When this material burns, three forms of nitrogen oxide result. At first, nitric oxide is given off. Composed of equal parts of nitrogen and oxygen, this is the harmless "laughing gas" administered by dentists. But on contact with the air, it oxidizes to the deadly nitrogen dioxide, composed of one atom of nitrogen to two of oxygen. The third form of the same compound is nitrogen tetroxide, containing two atoms of nitrogen and four of oxygen. Nitrogen dioxide mixed with water is nitric acid.

The report of the experts recommended that, to prevent recurrence of catastrophies of this character, inflammable films in all clinics and hospitals be stored in separate steel or other fireproof cabinets.

New Grand Canyon Bridge

A REMARKABLE new steel highway span, bridging the Colorado River at Marble Gorge, northwestern Arizona, was opened to automobile traffic recently with officials of Arizona and Utah participating in a two-day celebration.

Over this 616-foot bridge, 500 feet above the charging water of the Colorado, machines will speed into picturesque country hitherto inaccessible to motorists. For millions of years the river has been digging the Grand Canyon of the Colorado. Only now have the two sides of the chasm been linked by a solid road.

Once upon a time, the plateau, through which the canyon cuts, was ocean bottom. Gradually, through geologic ages, it rose above the water. The belief is that the turbulent water of the river, draining a quarter million square miles of territory, cut down as the land rose, in the manner of a saw biting into a log lifted against it. The "sawdust" from this cutting, the silt of the worn-away rocks, spreads out below the canyon forming the rich soil of California's famous Imperial Valley.

In some places along the 283 miles of the Grand Canyon its depth is more than a mile. Its width varies from a few hundred feet to twelve miles. Much of the wild gorge still remains unexamined. On either side, the walls stand like mile-thick books lying side by side, the layers of rock forming the "leaves."

How Much Do You Know about Timepieces?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. You will find a list of the correct answers on page 137.

1. **Is it bad to turn the hands of a watch or clock backward?**
2. **What is meant by adjusting a watch for positions?**
3. **What is the difference between a pocket watch and a chronometer?**
4. **Is there any watch that will keep perfect time?**
5. **How does a stop watch work?**
6. **What is "railroad accuracy" in a watch?**
7. **How was time measured before they invented clocks and watches?**
8. **What is isochronism?**
9. **What advantage has a pendulum clock?**
10. **Why is the day divided into two periods of twelve hours, with sixty minutes in each hour and sixty seconds in each minute?**

Victim of the Rattler

AFTER handling poisonous snakes for twenty years as head keeper of mammals and reptiles at the Bronx Zoological Gardens, New York, Charles E. Snyder died a few weeks ago from the effects of a rattlesnake's bite while hunting in the hills near Suffern, N. Y., for specimens with which to enrich the Zoo's collection. Two injections of serum, used with great success in numerous previous cases, were administered to Snyder in vain. The expert, confident that his experience would enable him to cope with the emergency himself, apparently applied too late for the serum treatment.

Snake-bite antitoxins are a comparatively recent development. The first serums were obtained in experiments some thirty years ago at the laboratories of the Pasteur Institute, Lille, France, under the direction of Dr. A. Calmette, famous authority on snake venoms. At that time, the annual death toll from snake bites throughout the world was appalling. In British India alone, they were responsible for about 25,000 deaths in one year!

THE poisons used at the Pasteur laboratories were imported from Cochin-China. Here representatives of the Institute studied the methods of the so-called "snake-charmers" and found that they did not hypnotize the reptiles but immunized themselves to their bites by self-inoculations with minute quantities of venom. The Frenchmen brought the poison, extracted from the cobra, most venomous of Asiatic snakes, back to the Institute. There, by mixing the poisons from several species of reptiles and experimenting with the mixtures on horses, the antitoxin was de- *(Continued on page 134)*

At the Throttle *of the* "Big Hog"

A Thrilling Ride in the Cab of a Crack Mountain Locomotive

By

ARTHUR GRAHAME

THE two-hundred-ton mountain-type locomotive *Philip E. Thomas* waited in the railroad yard at Keyser, West Virginia, to couple onto the Baltimore and Ohio's crack New York–St. Louis flyer, the *National Limited*. It waited to pick up a sleek string of Pullmans and haul them westward over the West End of the Cumberland Division—up the far-famed Seventeen-Mile Grade, the longest heavy grade in the East; over the 2,628-foot "hump" of the Alleghenies near Altamont; at last down the Cheat River Grade into Grafton on the far side of the mountains—eighty miles of the most spectacular railroading east of the Rockies.

Outside the cab the wind whistled bleakly between waiting box cars and coal-laden gondolas. Ahead, green switch lights reflected wanly on the polished steel rails. In the cab everything was warm and cozy, if a trifle sooty.

Old Man Grief was riding the rails of the Cumberland Division that night. The Potomac River, swollen by three days of driving rain, had overflowed its banks; in its valley trains were feeling their way gingerly along rails that were under six inches of flood water; and No. 1, the *National Limited*, would be twenty minutes late pulling into Keyser. With a clear fire burning in the fire box, and the steam gage showing two hundred and twenty pounds pressure, there was time for a little chat.

Engineer Jim Pugh, a stubby, solid man with firm mouth and keen eyes—typical of the American passenger engineer. Sure of himself, composed, keenly alert—the right man on the job.

"Clear block!" called Fireman Fazenbaker. "Clear block!" echoed Engineer Pugh, to avoid a mistake.

Engineer Jim Pugh—a stubby, solid man with a firm mouth and the keenest of eyes; a man who carries his forty-two years of mountain railroading lightly—settled comfortably on the leather-cushioned seat on the right side of the cab, glanced briefly at various illuminated dials, then turned a quizzical gaze on me and answered the question I had asked a moment ago.

"NO, I don't like riding in automobiles," he said. "Fifty miles an hour over the mountains in the cab of a fine engine like the 5501"—his gauntleted hand gently patted the bronze throttle—"with an all-steel train roaring along behind you, good hundred-pound steel rails under your drivers, and a white light shining on the signal mast telling you everything's clear in the block ahead—that's nothing to worry about. But it's different in an automobile—no rails to run on, no signals to warn you of danger, and nothing under you but a contraption pretty near as flimsy as the paper they write train orders on, and faster than a runaway freight headed for the Big Hole.

"'Railroad service involves hazard'—the 'Book of Rules' says that, and the 'Book of Rules' always is right—but railroad service doesn't involve one tenth as much hazard as taking what they call a pleasure ride in one of those gosh-blamed——"

Big, red-haired Fireman Fazenbaker stepped on a pedal protruding from the steel deck, the fire box doors opened with a clang, and the locomotive cab was flooded with a ruddy glow. I noticed a broad grin on Fireman Fazenbaker's soot-coated face, and as broad a grin on the face of Road Foreman of Engines Charley Schuh, my guide in this experiment in head-end railroading. In case you don't know, a road foreman of engines is an official who spends most of his time riding over his division in locomotive cabs, checking up on the performance of engines and enginemen.

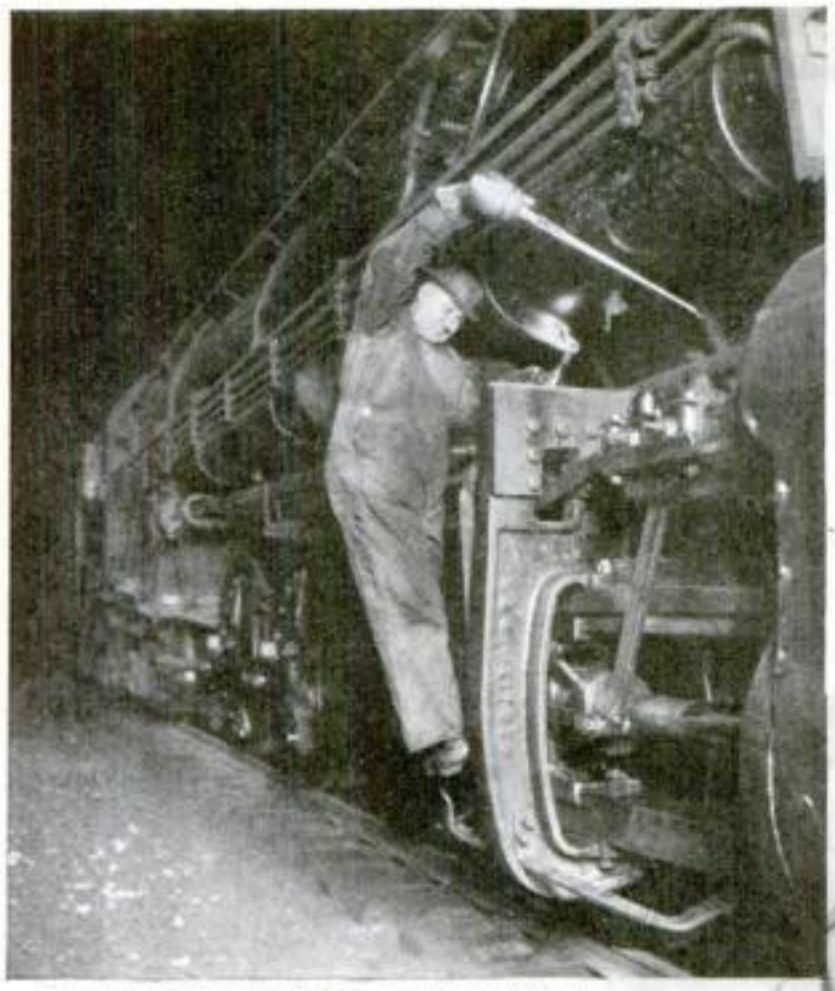
FOREMAN SCHUH leaned over until his lips were close to my ear. "That's the way with most veteran 'hogheads,'" he said. "Scared to death of automobiles. The 'tallowpots' are younger—most of them like to burn gasoline, and to kid the old fellows about it. What's that? Oh, yes—an engineer is called a 'hoghead.' When they got to building locomotives bigger and bigger, the firemen had to work harder and harder shoveling enough coal to keep up the proper head of steam, so they got to calling an engine a 'hog'—a coal hog—and then an engineer a 'hoghead.' A fireman is a 'tallowpot'—has been ever since the old days when they greased cylinders with tallow instead of with lubricating oil. But they don't like those nicknames—they'd much rather be called enginemen."

"Hey, up there!" Seven feet below us on the stone ballast appeared a brisk little man whose brass buttons gleamed in the lights of the cab—Conductor Mohler. He swung himself briskly up the iron ladder, compared watches with Jim Pugh, handed him a train order, remarked "Here she comes" as an electric headlight glared back of the station, and briskly swung himself down to earth. Jim Pugh read the order with care, then passed it over to his fireman.

Back of us a lantern waved in a small circle across the track—the signal to back. Our bell clanged softly. Jim Pugh reached up and swung the bar of the Ragonnet reverse gear, opened his throttle gently, and the 5501 backed down the track and coupled onto the waiting train without a jar.

Air brakes were tested. Two short blasts of the shrill air whistled in the cab. Without apparent effort the 5501 leaned against the long string of steel Pullmans, and we moved smoothly ahead.

IN A moment we were past the telegraph tower, out of the yard, and on the main line. Fazenbaker jerked at the whistle cord. "*Hooo-hooo-ho-ho!*" blared the 5501—fair warning for a grade crossing. Now we were moving faster. Under the cab the trailer wheels clicked ever more rapidly over the rail joints, fell into a definite rhythm, and seemed to sing "Gettin' outa town, gettin' outa town, gettin' outa town"—the song of the rails that the real railroader never can forget.



Jim Pugh was out of the cab oiling the locomotive almost before its drivers ceased turning.

The author, on the step of the big mountain-type locomotive *Philip E. Thomas*, says good-by to Engineer Pugh after a thrilling ride with him in the cab. Standing below is Charley Schuh, road foreman of engines. Left: Wheat cakes and black coffee at dawn in the all-night railroad restaurant at Grafton station.

Along lonely mountain sides, through cut and over fill.

Many and marvelous are the machines built by man, but few are more impressive or more complicated than is the modern locomotive. Something like 7,000 separate parts go into its building, and nearly all of these parts must be made and fitted with the careful precision of the parts of a fine timepiece. It was not for nothing that Matthias Baldwin, first of the world's great locomotive builders, spent his early years at a watchmaker's bench!

As the 5501 thundered on through the night I sat in the cab—the nerve center of this tremendous mechanism. Carefully shaded electric bulbs illuminated the dials of various instruments—steam gage, air pressure gage, water gage, speed indicator. Over on the right side Engineer Jim Pugh leaned from the cab window, his steady eyes on the right-of-way ahead, his steady hand on the throttle. Sure of himself, composed, relaxed physically and at the same time keenly alert mentally—the right man on the right job!

Fireman Fazenbaker, calmly efficient, eyed his steam and water gages intently; now and then opened the fire box door to peer at the inferno within. Now he stepped over to the left-side window, and looked out. My eyes followed his gaze. Far ahead, over the track, a white light gleamed on a signal mast.

"Clear block!" called Fireman Fazenbaker.

"Clear block!" came the answer from Engineer Jim Pugh.

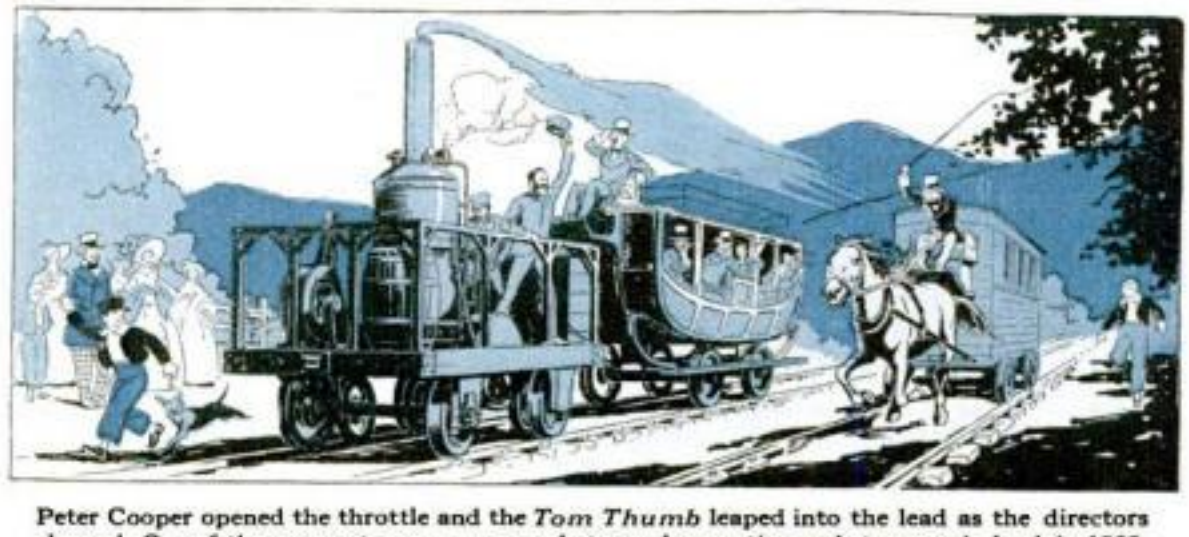
SWAYING and rumbling, the 5501 roared on through the night.

"Why do both of us call the signals? Just to be on the safe side," explained Jim Pugh. "Now, when I see a white light I *know* it's white—if I ever get to feeling doubtful about it, I'll stop running trains. But other engineers have seen red lights, and have been just as sure as I am that they were white. A lot of those men aren't alive today—the next thing they saw was the rear-end markers of a stalled train ahead of them, and then it was too late to avert a collision. And, speaking generally, an engineer who smashes into a stalled train doesn't live to tell about it—tons of wrecked steel and clouds of scalding steam see to that. But, to get back to the signals, two men are unlikely to think that the same red light is white, and that's why it's part of the fireman's job to watch the signals, and to call them. If he calls a signal, and the engineer doesn't repeat, it's up to him to cross over to the right-hand side of the cab and see what's the matter—more than one engineer has died of heart trouble, at his post, with his hand on the open throttle, and his train rushing at full speed to glory.

"Taking chances is the one thing that doesn't pay in railroading. There are engineers who are in such a hurry to get somewhere that they run past stop signals to get there—but you won't find them running good trains on good railroads. The most experienced engineers get the best trains—and the fellows who don't get killed running past stop signals get fired before their seniority entitles them to run a real good train.

"Looking back over the forty-two years that I've been railroading on this Cumberland Division—I started back in 1887, as a call-boy in

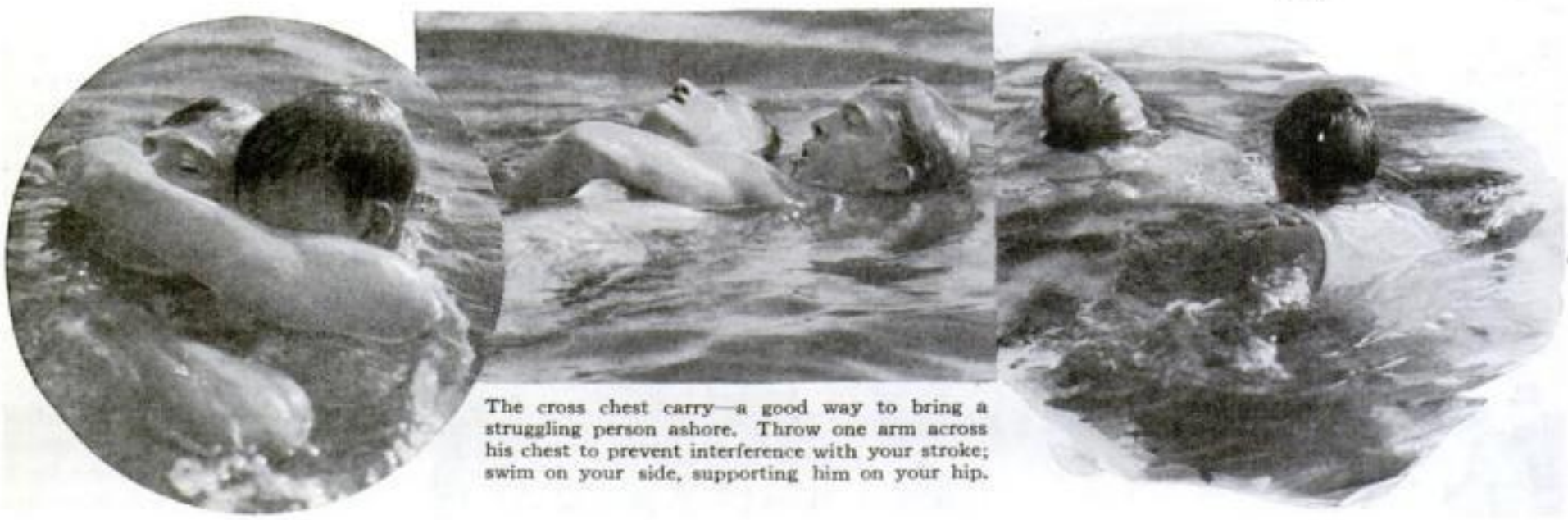
(*Continued on page 142*)



Peter Cooper opened the throttle and the *Tom Thumb* leaped into the lead as the directors cheered. One of the queerest races ever run, between locomotive and stagecoach, back in 1829.

To revive an unconscious person, stretch him out, as shown. Then press down and in on the floating ribs every four to five seconds. This will induce breathing.

How to Rescue a Drowning Man



The cross chest carry—a good way to bring a struggling person ashore. Throw one arm across his chest to prevent interference with your stroke; swim on your side, supporting him on your hip.

If a drowning swimmer throws his arms about your neck from behind, like this, you can break the hold by grasping and twisting one of his wrists. Then you can duck down, holding the wrist, and come up behind with a hammer lock and have him in your power.

An exhausted bather who is not struggling may be taken ashore easily by this "tired swimmer carry." Have him float face upward with his hands resting on your shoulders. This will leave both your arms free and allow you to swim with the breast stroke and push him to safety.

You can keep a struggling bather at arm's length while towing him in by pulling him along by the hair, face upward. This may look like an inhuman method of rescue, but it is one which may save your life — and his.

Photographs by D. Warren Boyer

SEVEN thousand persons are drowned each year, according to statistics of the National Safety Council, because no one capable of effecting a rescue is at hand to avert the tragedy. The pictures on this page tell you what to do to save the life of a drowning person.

The safest way to approach a struggling bather is from the rear. Otherwise, he may throw his arms about you in a death grip. One of the photographs shows how to escape such a grip.

The method of bringing a rescued person ashore depends upon his behavior. If he is still struggling, the cross chest carry, holding him in a position in which he cannot interfere with your swimming stroke, or the hair carry, towing him, face upward, by the hair, are best. If he is quiet, you can place both hands over his jaws as he lies on his back and, swimming backward, pull him to safety. An exhausted bather, otherwise normal, can be pushed to shore easily if he can float face upward and place his hands on your shoulders. Swimming with a breast stroke you can push him ahead of you.

Once ashore, resuscitation is accomplished, if needed, by a rhythmic pressure upon the floating ribs.

One of the most effective ways of keeping a drowning man's head above the waves while swimming to shore with him. Turn him on his back; then, placing both hands firmly under his jaws, swim on your back, using a scissors kick. After a little practice with these various methods of rescue, you'll be surprised to find how easily you can tow even a heavy person through the water. It pays to learn.

Bud Pearl, California contestant in Atlantic City model airplane meet, explains the fine points of his twin pusher to Mrs. Thomas A. Edison.

Model Planes in Amazing Flights

By EDWIN W. TEALE

ONE of the strangest accidents that ever befell a model airplane occurred over a field on the outskirts of Chicago. Members of the Illinois Model Aero Club were tuning up featherweight duration planes. Two of the little machines whirred into the air side by side. They mounted in great circles lifted by updrafts under low-hanging clouds. When they disappeared in the clouds, they were never seen again!

Repeated search of the vicinity revealed no trace of them. They seemed to have disappeared from the face of the earth. The theory is advanced that after entering the clouds, they flew for many minutes in a straight line, and when their rubber motors were unwound dropped into a field of tall weeds or among the branches of trees.

The flight of a model airplane is always an adventure. The unexpected spices it. No one can predict just what will happen. This is one of the reasons why, over the country, the sport of flying miniature planes is being taken up. About 200,000 enthusiasts belong to the Airplane Model League of America, which held a national contest at Detroit last year and sent two winners on a trip to Europe. A second nation-wide contest was sponsored by the National Playground and Recreation Association of America. Twenty thousand contestants entered local elimination meets, in which were chosen those sent to the finals at Atlantic City, N. J. Both organizations are holding similar tournaments this year, the League flyers meeting at Detroit and the Association contestants at Louisville, Ky. At the latter meet, an Amelia Earhart Trophy is offered as a prize to the girl entrant who makes the best showing.

SEVERAL dozen companies in the United States now deal exclusively in supplies for little planes. Miniature aircraft are being constructed in schools as part of elementary courses in aeronautics. Every large city has its club of model building enthusiasts. Summer camps and playground groups have model flying rallies, and in some cities, tiny hangars have been erected in public parks to house diminutive machines entered in local meets.

Of all the contest flights of last year, probably the most spectacular was that of a little rubber-band-propelled machine that started out to fly the Atlantic! Tudor Morris, of Peru, Indiana, entered the model in the Atlantic City tournament. Equipped with floats, it took off from a starting pool on the inland side of the city and, soaring high, headed over the buildings for the ocean. Men of the Coast Guard in fast motor boats were called upon to follow it during its record-breaking twelve-and-a-half-minute flight. They found it, nearly a mile from shore, riding the ocean waves on its tiny floats. The previous duration record for a model airplane with floats had been two minutes and fifty-three seconds.

Just like a real ship—a featherweight rise-off-ground monoplane taking off at the starting line in a distance contest.

FIELD glasses are now part of the equipment of judges at important meets so they can keep the models in view as long as possible. What often happened before this became the rule is illustrated by the hard-luck experience of Donald Shetland. In a meet at Providence, R. I., his fifteen-inch tractor was still flying when it went out of the judges' sight, and what might have been a record could not be counted.

Another racing model, launched at the Detroit meet by Joseph Lucas, veteran of the Illinois Model Aero Club, flew so far that it had to be hunted by an aviator in a real airplane! Speeding away on a bee line, the racer passed over a stream and disappeared beyond trees and fields of high weeds. It seemed hopelessly lost. However, an Army airman at Selfridge Field offered to make a search. Taking off in a fast plane he roared back and forth over the fields beyond the airport until he sighted the glistening wings of the little machine amid tall weeds. He kept circling and diving over the spot until Lucas arrived and recovered the model.

NOT all model flyers are as lucky. Thomas Hill, a sixteen-year-old boy from Winston-Salem, N. C., who won a trip to Europe at the same meet, never found his plane after its winning flight. To prevent the loss of valuable models during tests, many builders have started the practice of printing their names and addresses on the little planes so finders will return them in case

they fly too far afield.

The amazing records set by the latest miniature machines have been made possible largely through reduction of weight. Five years ago, a racing model three feet long, with a twenty-eight-inch wing and twin twelve-inch propellers, weighed from eight to ten ounces. Now the same machine can be built to weigh two and a half ounces. Refinement of detail and the wide use of lighter-than-cork balsa wood accounts for this striking advance. Equipped with the same amount of power as the heavier planes of the past, the modern thistledown craft floats through the air to new records for duration and distance.

The race is on! Launching a flock of speedy models in tournament at Hawley Airport, Los Angeles, Calif. Right: A twin pusher model gaining altitude in duration contest at Atlantic City.

Although wound-up strands of rubber remain the standard motor equipment for record-making models, other sources of power are constantly being tested. At the Atlantic City tournament each of five different types of power was represented in a separate contest. The most spectacular were the rocket planes. Some of them were ruled out, as they were simply Fourth of July skyrockets with flippers attached for wings! The craft that won the event was an ingenious little plane made by Burton Simcox, of Knoxville, Tenn. The "power plant" was a powder magazine stored in a drinking straw!

AIR escaping from a balloon propels a freak plane designed by Wilbur Reitze, of Baltimore, Md. Just before the start of each flight, Reitze blows up a long balloon to which wings have been attached. Holding the combination craft aloft, he releases the mouth of the balloon. The air, escaping violently in one direction, pushes the plane in the other! In a model made by Virgil Rossner, of Peru, Ind., compressed air drives the pistons of a tiny motor that turns the propeller. In one flight, it stayed up seven and a half minutes.

There are times when a diminutive aircraft will perform evolutions in the air just as though some Lilliputian airman were holding the stick in the tiny cockpit. For instance, when Frank Lauder wound up the R. O. G. monoplane (R. O. G. is an abbreviation of "rise off the ground") which he made from instructions in POPULAR SCIENCE MONTHLY, and placed it on the ground near his home in South Norwalk, Conn., it made a regular "test flight." Taking off after a short run, it banked in a wide circle to the right, came down in a perfect three-point landing, ran along the ground, and climbed again for a straight flight of more than 300 feet—all with one winding.

Another startling instance of a little plane piloting itself occurred during an indoor meet at Detroit. Aram Abgarian, a fifteen-year-old contestant, had stayed up all night making alterations on a single "prop" duration plane entered in the Stout Trophy Contest. When he launched the model in the great Olympia Hall, it climbed quickly to a height of sixty feet, avoiding steel girders near the ceiling, and at that altitude circled for more than five minutes. Then it began to descend slowly, as though trying to remain the last fraction of a second in the air. Although there was no evidence of drafts in the building, as the floating plane approached one corner of the auditorium, it banked, made a left-hand turn, and sailed along the wall to the opposite corner. There it banked again and, soaring close above the heads of spectators in the gallery, made a third right-angle turn and drifted to a perfect landing in the middle of the floor. It had more than doubled the world's indoor endurance record, its remarkable maneuvering during the glide accounting for many seconds.

The thrills of flying model planes, however, are not confined to those who break records. Queer adventures often befall the little machines built and flown by back-lot airmen. They add to the excitement of the sport. One of the most amazing was that of a model that kept on climbing after its main wing came off! Randolph Leach, of Montclair, N. J., had just launched his twin pusher and it was climbing at a steep angle when the rubber band holding the wing in place snapped. Instead of plunging to the ground, the machine, supported by the upward drive of its propellers, kept rising for several feet.

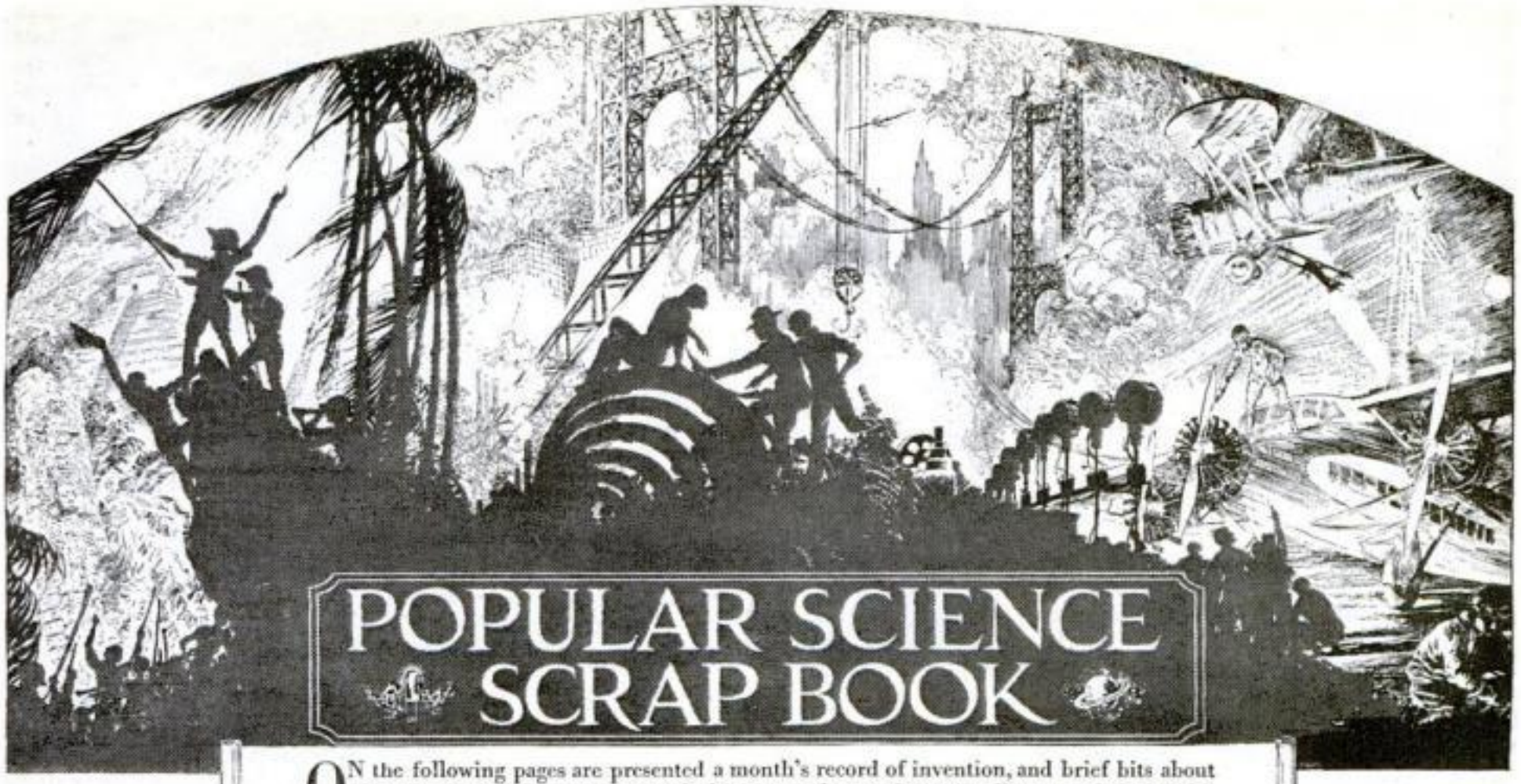
SCARCELY less startling was the flight of the "Shimmying Mosquito," a single-propeller tractor monoplane made by Irving Blumberg, of Astoria, N. Y. In a take-off, the whirling blade struck a telephone wire, breaking the propeller in half. But, to the surprise of watchers, the machine kept on flying. Jerked up and down by the uneven pull of the screw, it shimmied through the air for more than a minute.

Almost every new feat or innovation in big airplanes offers a challenge to the flyers of baby machines. When the monoplanes of the Byrd Antarctic Expedition were being equipped with skis, Wayne Brown, of Andalusia, Ala., replaced the wheels on his R. O. G. pusher with skis and accomplished some pretty take-offs from smooth stretches of trimmed grass.

Stories of the feats of balloon-strafing aces of the World War inspired a recent aerial dog fight in miniature. Toy balloons were released as targets for "fighting models"—pusher planes with pins sticking from the front. Each time a machine struck a balloon, the pin punctured it and another "enemy" plunged to earth.

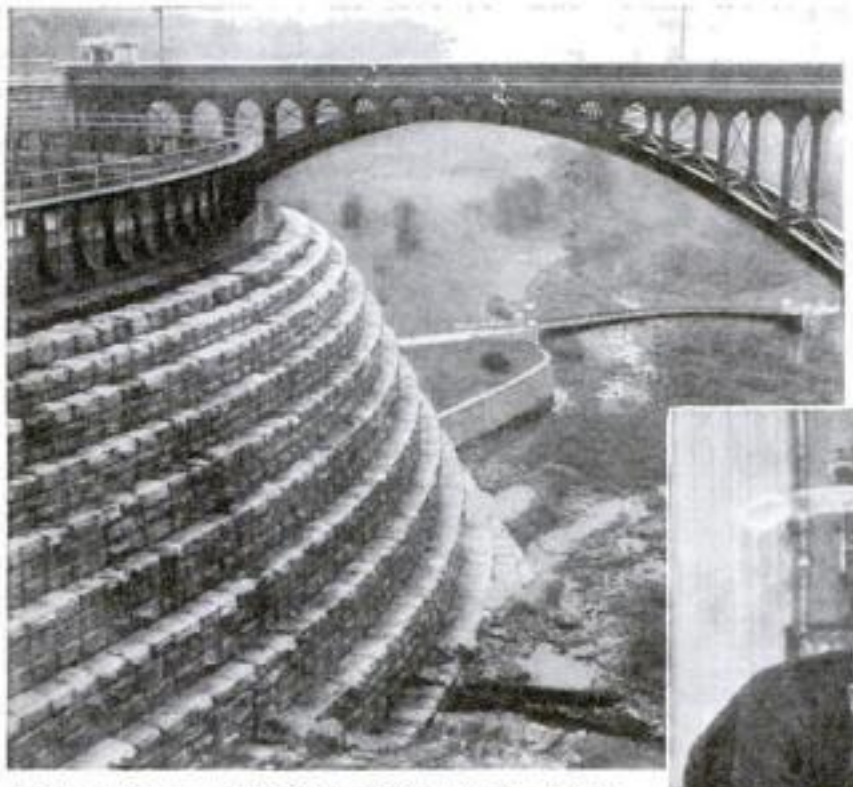
HOW fascinating the sport of flying toy planes may become is illustrated by a letter sent to an American supply company by a major of the U. S. Army, stationed in Hawaii. "This must stop," he wrote. "My son spends every cent he can get on models and accessories. Model flying absorbs all his spare time. He even neglects his studies to find time for it."

A trim model seaplane gathering speed for the take-off from starting tank at Atlantic City. From this tank Tudor Morris' model made its record-breaking 12½-minute flight out over the sea, as described in this article.



ON the following pages are presented a month's record of invention, and brief bits about the new, interesting and unusual things people are doing in all parts of the world.

Deadly Chemicals Purify City Drinking Water



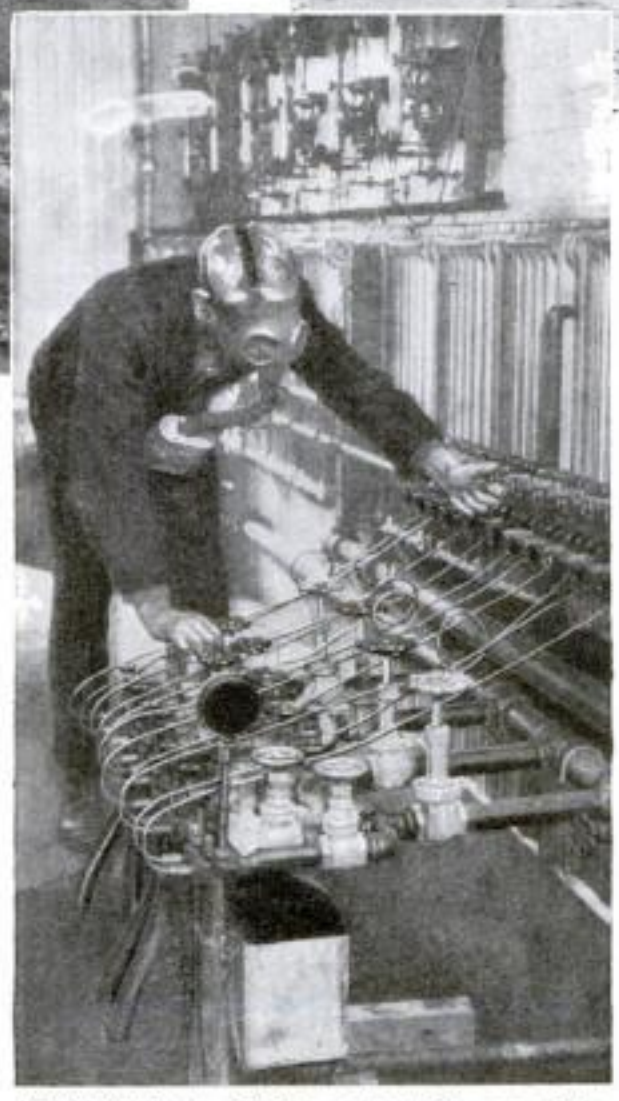
Behind the massive Croton Dam can be stored thirty billion gallons of water for New York City.

A few of Croton reservoir's 1,800 fountains. They continually freshen the water with oxygen.

DEADLY chlorine gas, one good whiff of which would bowl you over, is being used every day to safeguard millions of lives by purifying the drinking water of our cities.

Every drop of almost a billion gallons of water used every twenty-four hours in New York City has been made pure and healthful by this gas. A deadly enemy in one guise, yet—your best friend in another.

Thirty miles from the heart of New York City the huge Croton reservoir holds enough water to supply the world's largest city for more than a month. Thirty billion gallons can be stored back of its massive dam. But each day, before this water goes racing down to millions of thirsty throats, huge quantities of chlorine are used to attack and kill the little animalcules that might cause disease. An elaborate system of pipes carries the evil smelling gas into the water, where it takes its toll of death-dealing germs. Attendants must wear gas masks when they work around these pipes, or they might suffer the same fate as did thousands of soldiers during the war.



Risky business. Masks protect the men who work around the pipes of purifying chlorine.

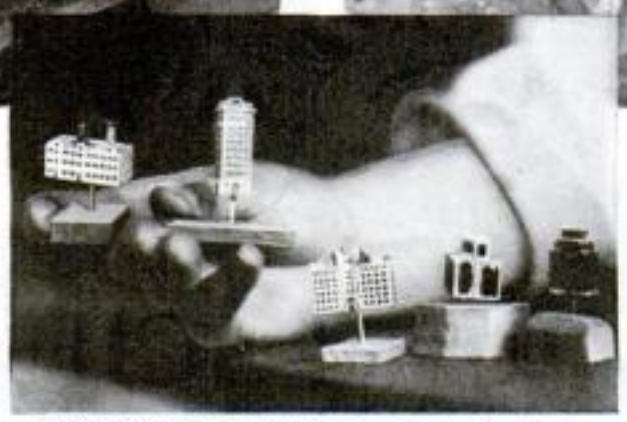
Sometimes the water in such reservoirs becomes bad-tasting, or has an obnoxious smell, caused by a vegetable growth in the water. Chlorine won't help this, but copper sulphate will, and so the latter is poured into the water as it rushes through the pipes. Copper sulphate destroys the tiny plants, so that the water which reaches the household faucet is perfectly pure.

You've noticed how flat water gets when left standing in a glass. The same thing happens to water kept in storage. So great fountains fling the water into the air and treat it with the oxygen that gives it life again. At the Croton reservoir eighteen hundred of these aerators, a veritable "park of fountains," help to make the water sparkling as any from a bubbling spring.

Builds Remarkable Scale Model of Coal Mine

A STRIKINGLY faithful miniature of a Pennsylvania coal mine, built to scale and complete in every detail, including shafts, elevators, breaker house, railroad tracks and cars, lumberyard, and even a power house, has been constructed by Donald Tiffany, model maker of Bayside, N. Y. The photograph above shows him with his latest creation.

It took Tiffany and his assistants three months to complete the model, every bit of which was carved, painted, and put together by hand. Tiffany considers the midget mine the finest thing he has made in a long career, in the course of which he has turned out countless ship models, airports, Pullman cars, factories, houses, and entire real estate developments. When a young man he was a cabinet-maker, but turned to model making.



How the midget buildings are anchored by nails on wooden pedestals. Comparison with the hand gives an idea of their small size.

Philadelphia in Miniature, a $100,000 Toy City

A WONDERFUL relief model of the city of Philadelphia, covering a base eighteen by twenty-two feet, fills an entire room in the offices of the municipal department of Wharves, Docks, and Ferries in the Quaker City. In meticulous detail, it comprises wooden miniatures of every building, street, sidewalk, bridge, and monument and even has tiny realistic representations of the trees, shrubs, and grass in famous Fairmount Park and Rittenhouse Square.

Several projected great buildings, among them the new station of the Pennsylvania Railroad, built to scale from architects' drawings, are featured also in the midget metropolis.

The reproduction has been made on a scale of one inch for every 250 feet. As the tallest building in Philadelphia is the 548-foot City Hall tower, this means that the highest structure in the Lilliputian City of Brotherly Love is only a trifle over two inches tall. Still, every detail has been worked out carefully, down to the ventilators and even radio aerials.

Work on the model was started in 1911, when the city zoning plan idea was first introduced in Philadelphia, but it has been brought up to date by Heber James, a city engineer, who is seen above placing a wooden miniature skyscraper in the center of the city. The skyscrapers are all carved by hand and held in place by nails protruding from little blocks of wood. Pieces of painted sponge are used for bushes and grass, and dyed putty stuck on pins for trees. The model's value is estimated at more than a hundred thousand dollars.

An "Old Ironsides" as Small as Your Hand

A SURPRISINGLY small model of "Old Ironsides," the doughty frigate *Constitution*, which won glory in the War of 1812, has been made by W. E. Haseltine, of Ripon, Wis. This gem of patient handicraft was built on a scale of one thirty-second of an inch to the foot. The length of the hull is six and a half inches—about an inch longer than the size of an average cigar! The usual ship-model scale is three times larger, one tenth of an inch to the foot. This is about as small as most people can do the job, according to Capt. E. Armitage McCann, noted model maker whose articles appear in POPULAR SCIENCE MONTHLY.

In the tiny reproduction of "Old Ironsides," fifty-two guns are turned of brass and mounted on miniature mahogany carriages. The dimensions of each are five thirty-seconds by three sixty-fourths of an inch, and they weigh only one and a half grains apiece! In this connection, it is recalled that all the copper and brass for the *Constitution* was supplied by Paul Revere, who was an artist, an engraver, an ironmonger, a coppersmith, and—a dentist!

The anchors on Haseltine's model are made of steel with mahogany crossbars; they are three-eighths of an inch long and weigh two grains each. The tiny fife rails are fitted with steel belaying pins a hundredth of an inch in diameter!

Old close-grain mahogany was used in building the little hull, but the masts and spars—the main mast measures five and a half inches from the deck—are from the spars of the famous old ship, and the double martingale, or dolphin striker, is made from a splinter of this identical part of the original *Constitution*, on a section of which the model is also mounted. Navy officials have requested the loan of the model for placing aboard the old frigate during a tour of American ports.

Scale model of "Old Ironsides," the hull of which is only six and a half inches long. W. E. Haseltine, the builder, is holding the small ship.

The model of the *Constitution* mounted on a portion of double martingale of the original frigate. Masts and spars of the model are from spars of the original. The foot rule in the foreground gives an idea of the tiny vessel's size.

Build a Model Helicopter

AN UNUSUAL article on page 81 of this issue tells how to build a remarkable helicopter model which has made a record flight of thirty-seven seconds. Included is a drawing of the helicopter toy which, in 1878, started the Wright brothers toward the invention of the airplane.

"Electric Eye" Turns on the Lights

WHEN does light get so dim you begin to strain your eyes? Human eyes cannot distinguish the exact point, but a supersensitive machine, designed by the General Electric Company to turn on lights in schoolrooms, can!

The light in the room falls upon a lens under which is a photo-electric cell, that translates light variations into corresponding electrical variations. When the intensity decreases to a point where strain on the pupils' eyes may result, the "light monitor" automatically switches on the lights by means of an electric relay. It determines infallibly when the button should be pressed.

An automatic time clock disconnects the apparatus during hours when the school is not in session.

Invents a Power Plant to Harness Small Streams

SMALL streams may be harnessed to generate sufficient electric current to light the farms of a neighborhood, if an invention by Frank L. Gaede, a filling station attendant of Plymouth, Indiana, realizes his expectations. His novel water power machine consists of a series of troughs carried on endless chains over sprocket wheels so they dip into the water at the upstream side and are carried back by the current, spilling the water on the downstream side.

The wheels turn between two pontoons floating in cement basins, which keep them from moving on a horizontal plane but allow them to rise and fall with the water. Thus the height of the stream does not affect the operation of the machine. In tests with a model, with fourteen-inch troughs, the inventor found that a small movement in the water kept the wheels spinning. A large machine, he concludes, could be operated by a small creek to produce electricity for home consumption.

Thrilling Whaling Scene Depicted in Model

MEMORIES of Herman Melville's *Moby Dick* are evoked by a unique representation of an old-time whaling scene which it took J. H. Webb, of Los Angeles, Calif., two solid months to carve out and mount. The model consists of a miniature of a full-rigged three-masted New Bedford whaler, standing by in a choppy sea while part of her crew of twenty-two men, in a small whaleboat, await the death of a "sea beast" they have just harpooned. There are two other whales in the scene; one is depicted "blowing" in characteristic fashion, and the other is swimming at full speed away from the fatal spot.

Webb, seen above with his model, made the ship out of bits of wood and copper and mounted it on plaster-of-Paris waves, appropriately colored. The sailors and whales he carved of solder. He gained his skill at this handicraft by whittling done in leisure hours during a career of forty-five years at sea.

The editor will be glad to supply, wherever possible, the names and addresses of manufacturers of the various devices mentioned in these pages.

Perfumed Glue and Shoe Polish

PERFUMING shoe polish and removing unpleasant odors from rubber goods are among some of the latest achievements of modern industrial chemistry. Experimenters in French industrial laboratories recently have made glue smell like violets and axle grease like attar of roses. Coumarin, a chemical derived from the tonka bean, the seed of a pod-bearing tree of Guiana; Bulgarian oil of roses, and aromatic compounds of benzene are some of the elements used in these magic transformations.

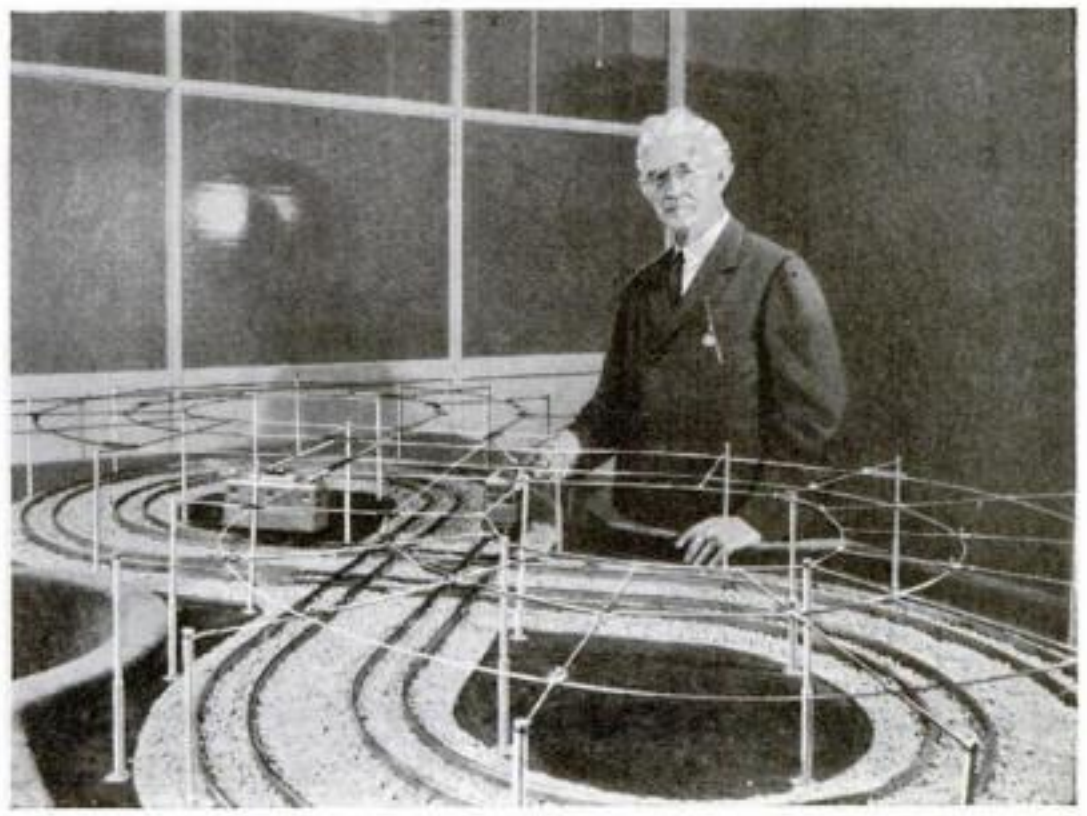
But substituting pleasant odors for disagreeable ones are not the only aims of this new branch of synthetic chemistry. Imitation leather has been given the fragrance of real Russian leather, and American chemists are now working on a process to impart an odor of Scotch and Irish peat smoke to domestic woolens.

Turntable Device to Stop Rail Crossing Jolts

STREET and railway cars may no longer bump over rail crossings if an invention of W. H. Whalen, a Los Angeles railroad man, proves successful in practical tests. In the usual intersection, grooves are cut across each rail wide enough to allow the flanges of car wheels to go through. When a wheel strikes one of these openings, passengers are jolted.

In Whalen's four-track crossing, this difficulty is overcome by the use of four small turntables, one at each rail intersection, and each containing a single groove. As a car approaches the crossing, they turn automatically, presenting the grooves in the right direction for the car to pass without encountering any cross grooves. A model, which Whalen recently exhibited, attracted the interest of California street car officials and a practical test was arranged.

Frank L. Gaede, of Plymouth, Ind., with model of water power plant he has invented to produce electricity from creeks.



Double-track model railroad with the new "joltless" rail crossings, demonstrated by the inventor, W. H. Whalen, of Los Angeles. Small turntables do the trick.

New Fire Boat Pumps 12,000 Gallons a Minute

SHOOTING powerful geysers of water from four huge pumps, a new fire boat, said to be the largest in the world, recently gave a spectacular exhibition in the bay at Seattle, Wash. The craft, named the *Alki*, has just been added to the fire-fighting equipment of the city. Seattle recently won a trophy for the proficiency of its fire department in preventing and extinguishing blazes. Last year it is said to have broken the world's per capita fire loss record, setting the new low mark of eighty-two cents per person for such losses.

The new fire boat can pump 12,000 gallons of water a minute when its machinery is working at full speed, as in the photograph above. Fifty such boats could pump enough water to supply all New York City! The largest city in America uses an average of approximately 600,000 gallons every minute.

Rudder in Bow Aids Liner to Make Sharp Turns

WHEN the helmsman turns the wheel of the *Princess Norah*, a new steamship recently launched at Vancouver, B. C., Canada, rudders at both the bow and the stern swing the boat in the desired direction. The vessel, designed for coastal service to the north of Vancouver, is unique in having a rudder at the nose. She was built for the Canadian Pacific Railway.

A glance at a map of British Columbia will reveal the importance of enabling a large vessel to squirm through narrow channels between jutting rocks of the innumerable islands that stand along the coast. The rudder at the nose of the craft is expected to allow it to alter its course suddenly and to circle in narrow quarters.

Pearls 25,000 Years Old Found in the Rocks

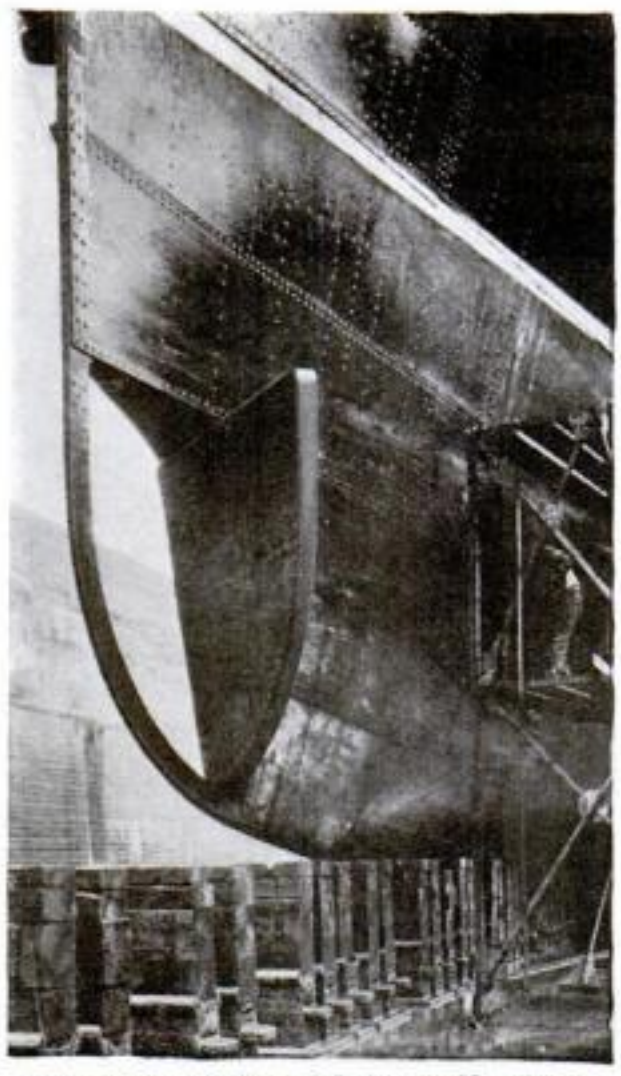
TEN of the oldest pearls on earth were found not long ago by geologists of the University of California in probing among rocks that were laid down 25,000 years ago. They came upon round fossil objects that proved to be real pearls, made by some prehistoric ancestor of the modern oyster. They range in size from three sixteenths to five sixteenths of an inch in diameter, and in spite of their great age, retain some of their luster. The find occurred near Redding, Calif.

Tails Handicap Squirrel "Channel Swimmers"

SWIMMING the Mississippi River is as great a feat for a squirrel, sizes considered, as swimming the English Channel is for a man. Yet W. T. Cox, Superintendent of the Upper Mississippi Refuge, reports that these little rodents frequently plunge boldly into the water and head for the opposite bank.

At first they swim with their bushy tails sticking straight up, as if to keep them dry. Later, as they weary in the struggle with the swift current, their tails sink lower and lower, until they are dragging in the water, making their progress more difficult.

In every case, Cox reports, the squirrels seem to have a definite destination in view when they start their long swim. When allowed to crawl up an oar into a boat, they will ride as long as the boat travels in the direction they want to go. If its direction is altered, they jump out and resume swimming! Gray squirrels, fox squirrels, and red squirrels all have been seen crossing the Mississippi.



Unusual bow rudder of *Princess Norah*, designed to aid steering through winding channels.

Windows of "Health Glass" Make Hens Lay More

QUARTZ glass has reached the chicken coop! Window panes admitting ultra-violet rays have been found to increase the fertility of eggs and to keep hens producing more of them.

That these mysterious rays also speed up incubation was discovered by two experimenters at the Mayo Foundation, Rochester, Minn., Dr. Charles Sheard and Dr. G. M. Higgins. When a quartz mercury arc, giving off ultra-violet rays, was added to the equipment of an ordinary incubator, twenty percent of the eggs were hatched from twenty-four to forty-eight hours sooner than other eggs of the same batch.

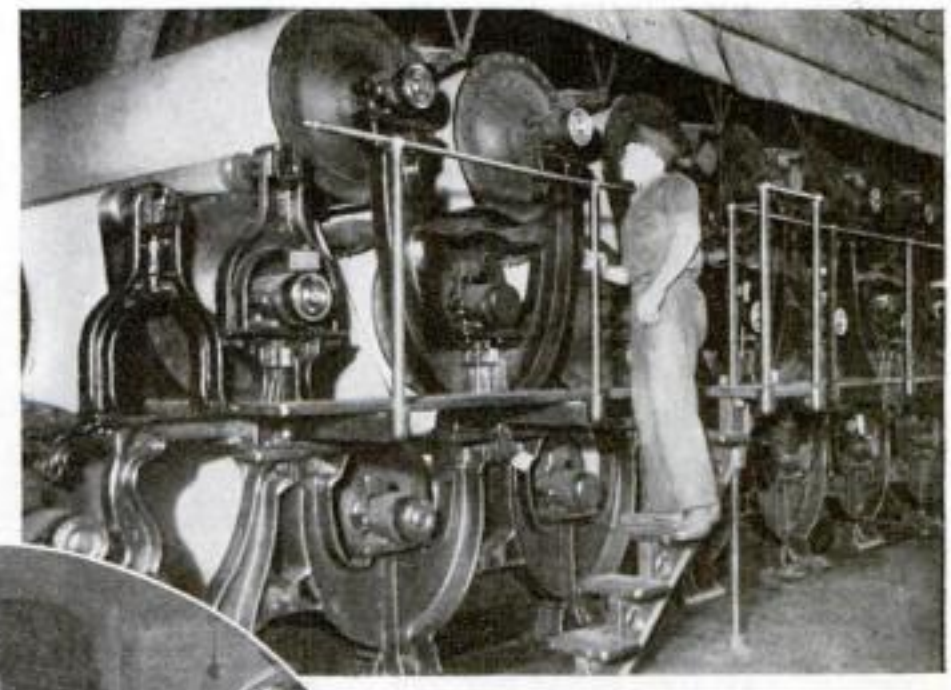
In coops where quartz glass is not used, the addition of cod liver oil to the rations of laying hens is said to have the same effect as treatment with ultra-violet rays, increasing their egg-laying record.

Gasoline Waste a Billion Dollars a Year

TO FEED the seven hundred and fifty million "horses" that power the automobiles of the United States during 1929 will require seventeen billion gallons of gasoline and four hundred million gallons of oil, according to Dr. Gustav Egloff, an oil expert of Chicago, Ill. Present automobile motors, he says, are only twenty percent efficient, so that about eighty percent of the fuel is wasted. This annual loss he calculates to be more than a billion dollars a year. When engineers design a gasoline engine of greater efficiency, much of this waste will be saved, Dr. Egloff declares.

Mountains of Waste Paper Salvaged by Machinery

Dumped into a steaming vat, waste paper is beaten into a pulp and colored brown.



Passing over a hundred rollers filled with steam, the paper is dried and toughened.

New paper made from old. A roll of the finished product on hand truck, ready for shipment and commercial use.

AT THE time of the Revolution, there was not enough paper in this country to wad the guns of the American soldiers and scarcely sufficient to carry the orders of the officers. In 1810, the consumption had reached a pound a year per person. Today, America consumes annually more than the combined weight of all the men, women, and children in the nation!

What becomes of these millions of pounds of paper, used and thrown away? The manner in which much of it is reclaimed and made into brown wrapping paper or corrugated cardboard is revealed by the pictures on this page, taken at a factory at Whippany, N. J. They show what happens to the old papers that you save up and sell to the junkman.

Huge storerooms receive the mountains of discarded newspapers and magazines when they arrive at the reclaiming plant. From these piles loads are carried into vat rooms within the factory. In these steaming caldrons, whirling arms beat the paper into pulp as it is fed in by the workmen. After passing through the maelstrom of a beating vat, the pulp goes through several refining processes and is colored to a brown hue. Then it travels to a great battery of steam-heated rollers, out of which streams the finished product.

More than a hundred of these hollow rollers, filled with steam, dry and toughen the paper as they press it into an endless sheet. Emerging, it is spun on rolls to be shipped. This is the process followed in making the wrapping paper. The manufacture of the corrugated cardboard follows much the same procedure up to the final steps, when the pulp is put through special machinery.

Strange Dance of Smoke Seen under Microscope

WHAT a puff of smoke really looks like is revealed by a high-power microscope apparatus recently installed at the Museum of Peaceful Arts, in New York City. A visitor who blows cigarette smoke into the apparatus can see individual particles of smoke dancing in a curious, erratic way beneath the lens, darting first in one direction and then another. Their strange motion, called a "Brownian movement," is explained as due to their collisions with the invisible molecules of air that surround them.

Drafty Dwellings Better for Our Health?

A HOUSE should be so uncomfortable that people will not stay in it too much, according to Dr. Leonard Hill, British pioneer advocate of sunlight and ultra-violet rays for the promotion of health. If homes are too comfortable, he says, growing children may stay indoors and play when they ought to be out in the sunlight and open air. On the other hand, if they grow up in drafty and cold dwellings, they exercise more and in the end live under more healthful conditions.

He declares there is much to be said scientifically in favor of the light, flimsy houses of the Japanese—dwellings which favor outdoor life—and contends that our modern homes are warmer and more substantial than they should be.

Skulls Used as Drinking Bowls in Tibet

NEW light on the mysterious land of Tibet and the strange customs of its inhabitants was shed recently by a collection of bone objects brought from that forbidding mid-Asiatic plateau by an expedition of the Field Museum of Natural History, Chicago, under the leadership of Dr. Berthold Laufer. Among the interesting articles in this collection are bowls made of human skulls, used for libations in honor of the Lama gods; trumpets made from human thigh bones; tambourines fashioned out of human skullcaps, and a bone apron consisting of forty-one large plaques exquisitely carved from bones and connected by double chains of round and square bone heads.

Dr. Laufer, curator of anthropology of the Field Museum, explains that the skull bowls, some of which are elaborately decorated, lined with gilded copper and fitted with metal lids, are used by the Lama priests to pour liquor on the altars of their temples as tribute to the gods. The Tibetans also use these bowls in a peculiarly barbaric form of ancestor worship, which prescribes that a dead man's son preserve his father's cranium and drink from it to his parent's memory on his birthday anniversaries.

The thigh-bone trumpets are blown to summon or disperse evil spirits. Either the bones of criminals or of persons having died violent deaths are used in their construction. The bone tambourines are shaken while reciting prayers. And the bone apron is used by magicians during secret ceremonies to pacify evil spirits and cast out demons.

High Speed Grinding Tool for the Shop

A SPEED of 25,000 revolutions a minute is said to be obtained directly, without the aid of gears or pulleys, from the small motor of a new grinder for shop use. This speed is made possible by using a rotary frequency changer, which raises an alternating current from sixty cycles to 420 cycles.

The surface of a half-inch abrasive wheel, rotating at this high speed, travels more than half a mile every sixty seconds, enabling it to do fast cutting not possible at 3,500 revolutions a minute, the speed of the usual shop grinding head. The frequency changer is separate from the grinding motor and one changing apparatus will supply current at higher frequency to several motors.

Another innovation in the new tool is the method of oiling the ball bearings. While a continuous supply of oil is necessary, too much is objectionable. An automatic system sprays a fine mist of oil continuously over the bearings. After lubricating the bearings, the oil drains back into a reservoir to be used over again.

The new grinding tool with small high-speed motor. The surface of half-inch abrasive wheel at right speeds half a mile every minute.

Left: Grinding a plumber's die with the new tool. Its high speed permits unusually rapid cutting.

He Washes Dishes All Day to Test New Product

IF YOU dislike to wash dishes, you won't envy the job of Wilhelm Nauer, of Pittsburgh, Pa. He washes twenty trays, all day long, every day in the week. Nauer is a "scientific dishwasher" employed by the Westinghouse Electric and Manufacturing Co., to test a new kind of tray made with a paper base upon which a resin composition is baked. This composition is used also in making certain types of propellers for airplanes.

Every three and a half minutes, Nauer finishes scrubbing and wiping a tray. He will keep this up, month after month, until the trays wear out! The purpose of the unusual experiment is to determine the wearing quality of the new product.

In manufacturing propellers, the resin composition is baked upon a canvas base. Propellers made in this way pulled the tri-motored Fokker monoplane, *Southern Cross*, on its flight from San Francisco to Australia, and carried Maitland and Hegenberger, U. S. Army flyers, across the Pacific between America and Hawaii. Such propellers came into use during the war when black walnut, of which the screws were largely made then, became scarce, and a synthetic product was sought as a substitute.

All day Wilhelm Nauer, of Pittsburgh, washes and wipes trays to find how long they will wear.

Novel Pipe Wrench Grips Like a Human Hand

A WRENCH that grips a pipe like a human hand and is said to break the tightest joints without marring or chewing the surface of the metal is the latest aid to plumbers. Three curved chain links are hinged to the base of the wrench handle. They encircle the pipe, and a lip at the end of the last link hooks over a second lip on the base of the handle so that a slight pull on the handle tightens the grip of the links about the pipe. A movement of the handle in the opposite direction relaxes the hold of the links.

Thus, a perfect ratchet action is possible and the tool can be used in close quarters, it is reported. The fact that the wrench is without teeth is said by its makers to allow it to be used without damaging threads or marring brass pipes.

Chain links, in place of jaws, circle the pipe and grip it tightly with pull of the handle.

Smartest Children Are Strongest

UNUSUALLY smart children are taller and stronger and weigh more than less intelligent boys and girls, tests among New York public school pupils showed. The experiments were undertaken by a Columbia University professor to disprove the belief that the minds of geniuses are housed in puny bodies.

The investigator compared a group of forty-five children, each of whom was the smartest among 200 schoolmates, with an equal number of average intelligence, duplicating each pair in sex, age, and race. Their development was watched for seven years and the difference in size, weight, and strength remained in favor of the gifted boys and girls.

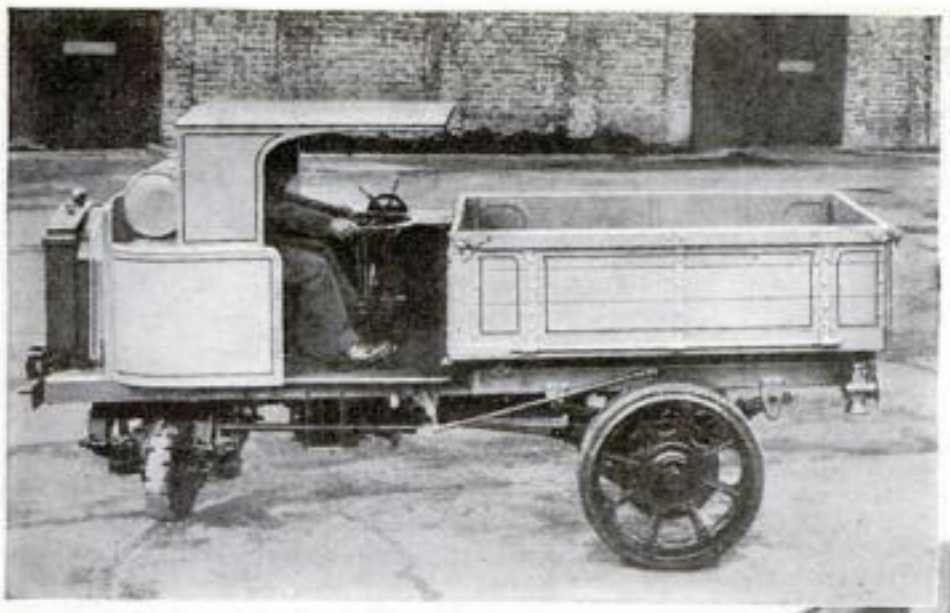
At the age of about ten years, the average height of the clever children was 52.9 inches as against 51.2 inches for the less gifted ones, and the average weight of the prodigies was 74 pounds as compared with 63.9 pounds for the others.

Strength measurements showed that a good brain is usually accompanied by a strong right arm. The bright children had an average grip of 55.11 pounds, as compared with 51.58 for the duller pupils.

Fountain of Racing Atoms May Explain Aurora

A FOUNTAIN of atoms, untold billions of invisible particles rushing thousands of miles into the sky above the tropics and descending at the earth's magnetic poles, is pictured by Dr. H. B. Maris and Dr. E. O. Hulburt, of the United States Naval Research Laboratory, Washington, D. C. In a recent report to the American Physical Society, they suggest that at great heights the atoms of rising air gases become electrified by ultra-violet rays from the sun. They are thus attracted, according to the theory, toward the magnetic poles, rushing at a speed of more than 5,000 miles an hour through the upper atmosphere.

Such a hypothesis, the Navy physicists declare, would explain the manner in which polar regions are provided with electrical energy to display the flashing brilliance of their auroras.



Left: The strange three-wheel truck. The load is carried in front and the driver in the rear. On the highway it appears to run backwards.

Below: Labor-saving machine for sorting various sizes of nuts, screws, or bolts. Dropping between the threaded rods shown in the photo, they fall into bins.

Odd Tricycle Truck Turns in Its Own Length

A TRICYCLE motor truck that swings around in a complete circle in its own length and appears to run backwards was recently put through successful trials in London, England. The load is carried in front, and the motor, tanks, steering gear, and driver's cab are at the rear. Two ordinary-sized truck wheels with solid rubber tires bear the load at the front, while a single smaller rear wheel is pivoted at the center of the truck frame for steering.

Because of the ease with which the unusual motor conveyance can be whirled about or maneuvered in cramped quarters, the makers believe it will be widely adopted for use in congested city districts. Comparatively small in size, it is especially adapted for light hauling.

By progressing in "crawfish fashion," with the motor behind and the load before, the vehicle, it is claimed, can be driven up to loading platforms or curbs with greater accuracy and less effort than is the case with trucks that have to be backed into such positions.

Gas Pump Dial Safeguards Against Short Measure

A "MECHANICAL watchdog," to protect motorists from short measure at gasoline filling stations, is the invention of A. R. Mason, of San Francisco, Calif. The device is attached to the gasoline pump and is said to keep an accurate record of the amount of fuel that passes through the mechanism and to show this record on a dial clearly visible to the car owner.

At the end of the filling operation, the device automatically stamps a receipt giving the number of gallons of gasoline purchased. Sales up to thirty gallons are recorded by the invention.

Oxygen Piped in Hospital

IN A manner similar to that in which illuminating gas is piped into a house, oxygen now may be supplied to rooms in hospitals so that a constant supply is available at all times for administration in emergencies. A new invention which was devised to regulate the flow of this precious gas is said to make such an arrangement possible.

Ingenious Machine Sorts Screws, Nuts, or Bolts

A MACHINE that sorts various sizes of screws, nuts, or bolts that have been reclaimed from wrecked buildings, and places them in separate bins, has been invented by a Torrance, Calif., shop worker. It eliminates the tedious process of sorting by hand. A pair of revolving threaded rollers, driven by an electric motor, receive the odd-sized pieces from a hopper at one end.

Under the hopper the rollers are close together, gradually spreading apart. Thus the smaller pieces fall through first. The larger ones ride along until the openings between the rollers are large enough to admit them. Bins below catch the different sizes as they drop. Only one kind of material is handled at a time, the screws, nuts, and bolts being run through the machine separately.

New dial recording attachment for gasoline pumps and its inventor, A. R. Mason, of San Francisco.

New Rustless Steel Cuts Glass Like a Diamond

STEEL so hard it scratches glass like a diamond, does not rust, and retains its hardness even when red-hot, is now being produced in America by a nitrating process discovered some time ago. When an inexpensive form of steel is treated in a hardening box with circulating ammonia gas heated to a high temperature, it develops the thin, hard, rustproof skin distinguishing the new metal.

Recently nitrated steel pins and bushings in a mechanism for starting and stopping electric motors were subjected to a gruelling test by the Westinghouse company. After the machine had performed its function some 22,000,000 times, inspection showed that all parts of it were worn out except the pins and bushings. They were as good as new.

Many everyday uses for the new metal have been suggested. Safety razor blades of nitrated steel, it is pointed out, would never lose their edge, nor rust. Plowshares could be left out in all weather without rusting, and bearings made of the metal would run until they became red-hot without losing their hardness.

Two 1,000-Foot Steamers Planned in England

IMAGINE a steamship which, if stood on end and placed beside the Woolworth Building, would top that skyscraper by 208 feet!

That is the size of two giant vessels planned by the Cunard Line, of England. Each of the enormous liners would be more than 1,000 feet long and have a displacement of at least 75,000 tons!

The new ships would be the world's biggest. The present championship is a matter of some controversy. The British White Star Line claims it for the *Majestic*, originally the *Bismarck*. This is contested by the American owners of the *Leviathan*, formerly the *Vaterland*. The *Majestic* measures 915 feet six inches in length; the *Leviathan*, 907 feet six inches. Dr. Ernest Foerster, consulting engineer of the Hamburg-American Line, who designed both steamers, said his original plans made both identical in size, but that, through a change in design, the *Majestic* was lengthened eight feet. This change is estimated to have added 700 tons of displacement, so that the *Majestic* now has a displacement of 64,800 tons, as against 64,100 for the *Leviathan*.

Rowing practice in the fighting mast of the U. S. S. *California*. Here the huskies of the crew develop skill and brawn on a rowing machine; the "oars" are grips attached to pulley weights.

Warship's Oarsmen Train in the Fighting Top

ONE of the oddest training quarters for a rowing crew is the fighting mast of the U. S. S. *California*. Here the oarsmen, who represent that battleship in rowing contests, take their daily work-out. Their practice equipment is a rowing machine designed to duplicate, as closely as possible, an actual racing shell. Stripped to the waist, and bracing their feet in toe holds, the husky gobs "row" with "oars" consisting of grips attached to pulley weights, while the coxwain stands by, timing the strokes.

The fighting mast is a tower of latticed steel designed to hold observers during a sea battle. It is made with weblike construction so that if a shell should plow through, it would still stand. If made solid, it would come down in ruins if a big shell struck it. Because the "cage" is completely open on all sides, the oarsmen practice under the same outdoor conditions of an actual race.

Novel Draftsman's Compass Designed for Precision

A NEW draftsman's compass has been designed to eliminate the faults of the familiar two-legged instrument with which circles are usually drawn. The improved compass consists of a needle-pointed vertical post, from the center of which an arm runs horizontally. This arm, marked in fractions of inches on one side and centimeters on the other, carries a slide to which is attached a holder for the marking lead. Thus, by moving the slide along the measuring arm, the scriber can be adjusted accurately so as to obtain any desired radius.

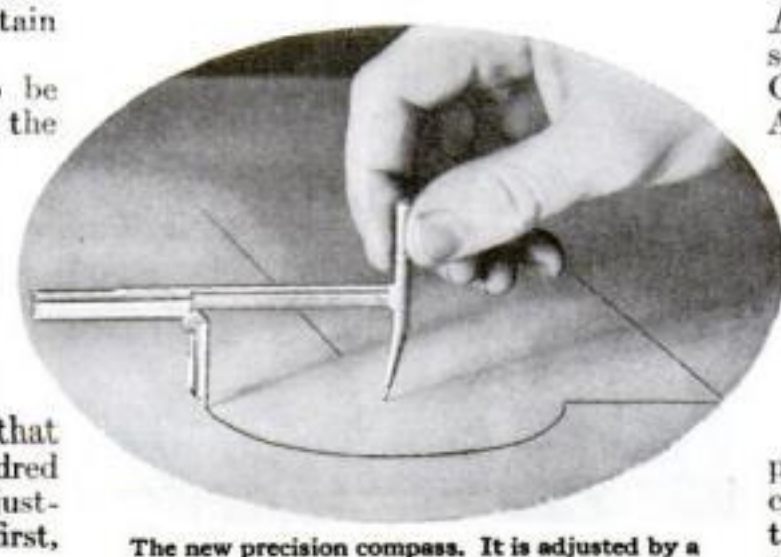
To fix the radius of a circle to be described with the ordinary compass, the two legs are adjusted near the hinge where they join. A slight error at this point is magnified at the tips of the legs. Also, the legs sometimes spread slightly while the circle is being traced and cause inaccuracies. The improved compass is said by the makers to eliminate both of these possibilities of error. It is claimed that after the compass has drawn a hundred consecutive circles, so fixed is the adjustment that it can go back over the first, tracing the original line exactly.

Every time you sock it a good one, the "shadow ball" pictured below is likely to snap back and land you one on the nose. A rubber cord attaches it to headband. The latest for boxing practice.

Combines Shadow Boxing with Bag Punching

A PUNCHING bag that follows you around the room has been designed by H. O. Costello, a former boxer and athletic trainer, to combine the benefits of bag punching and shadow boxing. A ball, which serves as a punching bag, is attached by a rubber cord to a headband worn by the boxer. When it is struck, it flies out, the rubber band quickly snapping it back at the striker. In punching, dodging, and ducking, all the footwork and headwork of an actual ring contest are demanded from the user of the device, the inventor declares.

Exercising with the ball is said to give a complete work-out of all the muscles and to be excellent training for boxing. The photo above shows the device in use.



The new precision compass. It is adjusted by a slide which moves along the horizontal arm.

Secret of Film Pictures Found in Cattle Food!

THE film in your camera records photographs because cattle don't eat pure food. That, in effect, is the partial explanation of a long-standing mystery given by Dr. C. E. K. Mees, noted American photographic expert. The average snapshotter goes on taking pictures without bothering much about why specks of silver salt in a coat of gelatin on the flexible celluloid film turn black when light hits them. Though this is the phenomenon on which all photography is based, it has puzzled chemists for more than a generation.

Now Dr. Mees finds that the specks of silver bromide used to impregnate the film are not alone responsible for its sensitiveness to light, as was long supposed. Traces of a sulphur compound which he finds in the gelatin coating play an important part in making the silver crystals more sensitive. Gelatin used in films is made from the hides of cattle, and Dr. Mees says that the sulphur is there because the cattle eat plants that contain impurities.

Although the exact mechanism by which the sulphur does its work is still not perfectly understood, it seems likely that if there were a "pure food law" for cattle, there might not be any more picture-taking.

Curious Mineral Squirms and Sweats under Heat

A STRANGE mineral that writhes and perspires like a man when flame is applied to it, has been found in a large deposit near Libby, Mont. Called vermiculite, it has previously been discovered in small quantities in several parts of the United States.

The Montana find was revealed by a prospector who was searching through an old tunnel in the Rainy Creek district. He noticed flakes of coarse, micalike material writhe and swell and give off water when touched by the flame of his candle.

Although no commercial use has been found for vermiculite, its properties suggest that it may be valuable as insulating material; for, when expanded, it is very light, has a golden or silvery luster, and has low heat conductivity. Some types of the mineral burst into long threads when heated. The Libby deposits are accompanied by asbestos and feldspar.

Army Tests Poison Gases on Hosts of Tadpoles

A SWARMING legion of more than 20,000 tadpoles became martyrs to science last year in the laboratories of the Chemical Warfare Service of the U. S. Army. The different poison gases with which the Service is experimenting are tested upon the wiggling "tads" to discover the exact amount required for a fatal dose.

Experts of the laboratory say that the reaction of a tadpole to poison is similar to that of human beings, and for this reason they form a cheap and effective means of testing the war poisons. Four shipments a year, each containing from five to ten thousand tadpoles, are supplied by Army men engaged in swamp dredging in Tennessee.

Comets Hauled from Space by Our Solar System?

A NEW theory of the origin of comets was advanced recently by Dr. N. T. Bobrovnikoff, of the Lick Observatory, California. He suggests that a million years ago, when primitive man was already on the earth, our solar system swept through a meteor-sprinkled part of space, carrying off comets in the same way that a speeding motor car will catch insects in a swarm and pull them along with it.

This belief is strengthened, he declares, by mathematical theories of the movement of heavenly bodies, which indicate that our solar system is using up its celestial fireworks and that comets are getting scarcer. Somewhere, billions of miles in the direction of the constellation Orion, lies the cloud of scattered meteoric matter where the "comet catching" took place, according to Dr. Bobrovnikoff.

A striking feature of comets is the small amount of solid matter they contain in proportion to the size of their streaming, gaseous tails. The famous comet of 1882 was estimated to have a tail a hundred million miles long. Yet, the famous British astronomer, Sir John Herschel, declared all the solid matter in it could be packed into a traveling bag!

Ancient Roman House Had Furnace and Bath

THAT the ancient Romans used hot-air furnaces in their homes is shown by the arrangement of the foundations of a Roman villa, probably built toward the end of the third century, which was recently unearthed in Hampshire, England.

The basement has an outer wall of flint set in cement, from which a flue leads to a furnace chamber. A layer of soot on the floor and walls of this chamber indicates that the house had an underground heating plant. This is further proved by channelings under the floors and flues in the walls through which the heat was circulated.

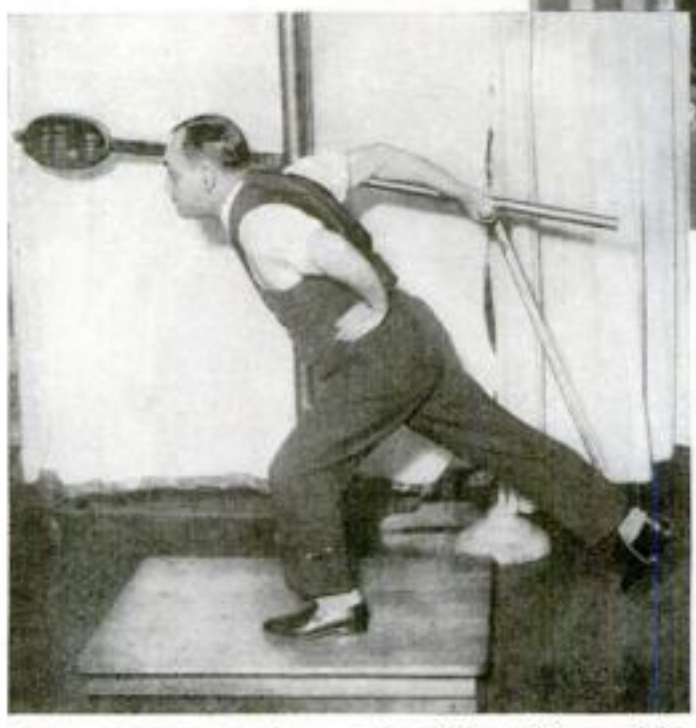
Below the remains of a tessellated floor raised about three feet above the furnace chamber is a small drain, which suggests that the villa also had a bathroom. Discovery of a coin bearing the likeness and name of Emperor Constantine the Great, who reigned in the beginning of the fourth century, served to establish the approximate age of the house. The archeological treasure was discovered accidentally by a farmer who came upon it while planting an apple tree.

Handy Typewriter Lamp Shields from Glare

A LIGHTING attachment that illuminates the keyboard of a typewriter, but shields the glare from the eyes of the typist, is part of the equipment of a new portable machine. The electric lamp, on an adjustable lever at one side of the machine, is equipped with a curved reflector which directs the light down on the paper and the keys. Current is supplied to the lamp through a cord which can be plugged into any convenient outlet. The light can be adjusted to prevent reflected glare from the paper. The new attachment is said to eliminate much of the eyestrain from night typing.

A New Way to Get That Exercise

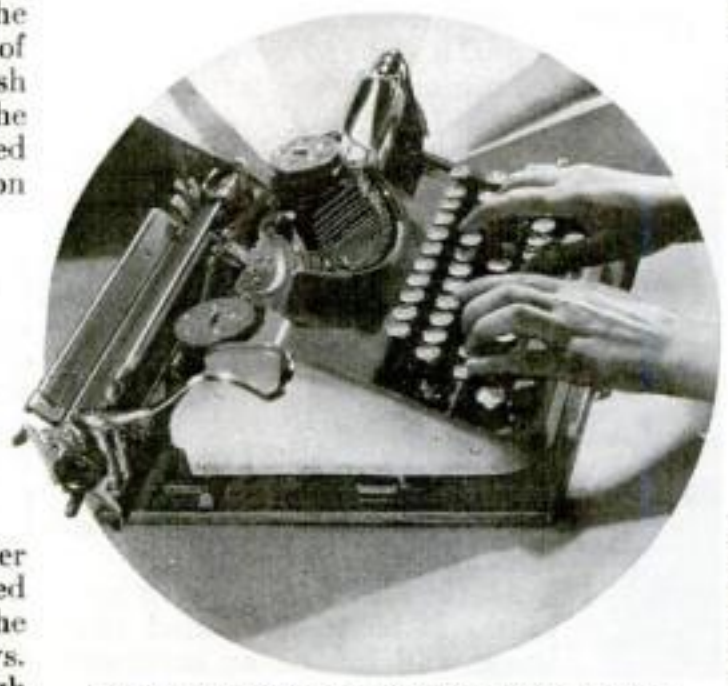
AN INGENIOUS exercising apparatus, invented by a French physical culture instructor, can be set up in the home and is said to strengthen all muscles of the body. It consists of a steel rod, with a weight at one end and a handle and a stirrup at the other, pivoted on an upright metal post.



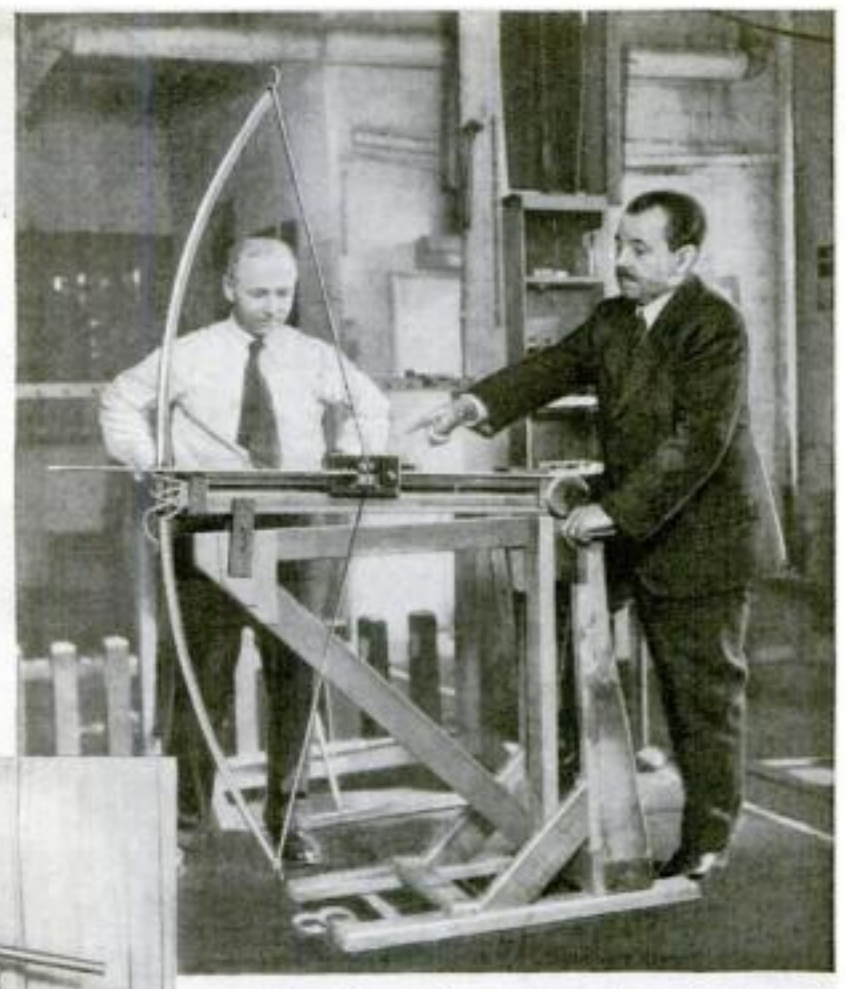
The new home exerciser—a pivoted bar with a weight at one end and handle and stirrup at the other.

In using the apparatus, one foot is extended back of the body and placed in the stirrup, while the hand on the same side grasps the handle. The weighted rod is pulled down with both hand and foot until the muscles are tired. The handle is then shifted to the opposite side of the rod and the muscles of the other side of the body are exercised in similar manner.

The apparatus can be adjusted to suit the height and strength of the user.



Shaded lamp at right of machine throws light on the work while shielding the typist's eyes



Mechanical Archer Tests Arrows for Defects

A WOODEN bowman that shoots every arrow in a quiver with the same speed and with equal accuracy, tests the "ammunition" used by the Archery Club of Seattle, Wash., to detect arrows that are defective. The mechanical archer is the invention of Rev. J. J. Pflueger, a Seattle pastor and a member of the club, seen at right in the photo.

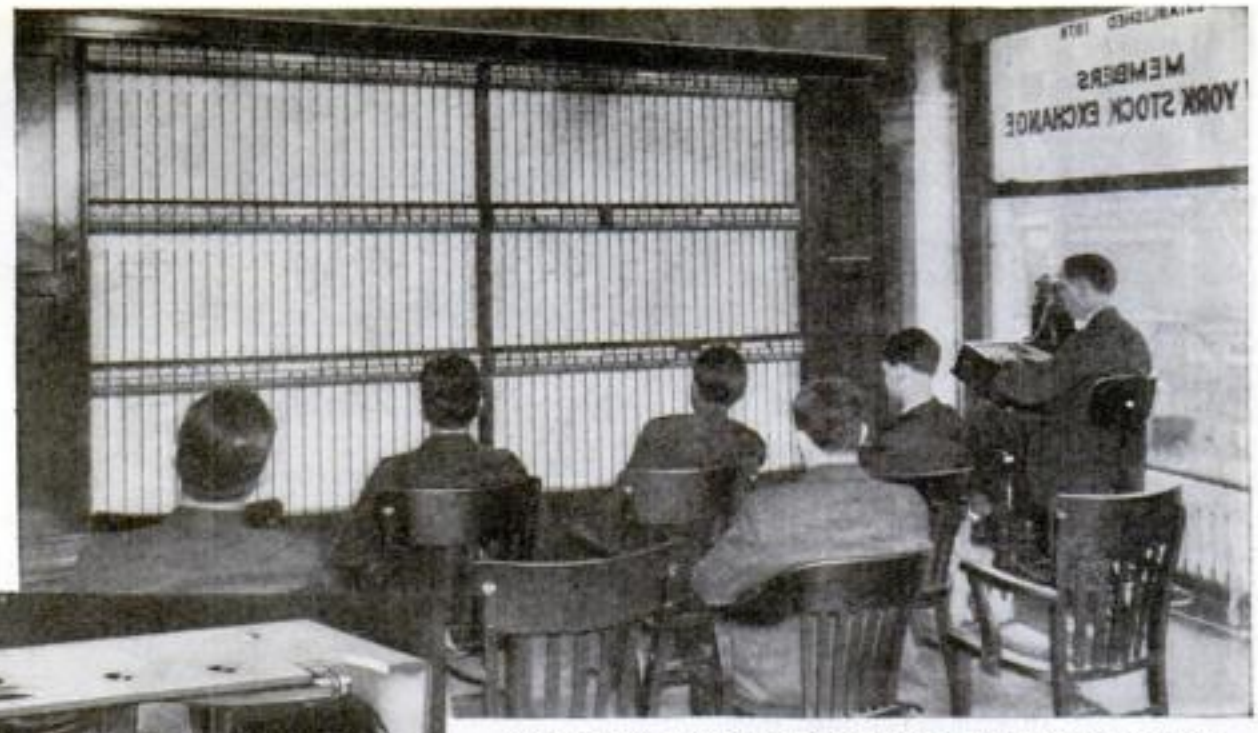
The wooden platform of the device holds the bow at the front, while the bowstring is pulled back by a sliding block attached by a cable to a pedal at the rear of the apparatus. String and arrowhead are gripped by two notched wooden wheels in the sliding block. These turn as the block is pulled back, engaging notches in the platform, in a sort of ratchet arrangement. After the pedal has been pushed down, drawing back the bow, a trigger is sprung to release the wheels, allowing them to turn and letting go the bowstring to drive the arrow. The force of the shot is determined by the distance the pedal is depressed. The elevation of the platform, determining the angle at which the arrows are shot, is regulated by a sliding arm at the front of the apparatus.

Besides detecting defective arrows, the machine enables the club members to trim the feathers of all arrows so they shoot the same under the same conditions. When shafts have passed the test of the wooden bowman, and then fail to hit the bull's-eye in subsequent tournaments, the club members know the fault is with the archer and not the arrows.

Tunnel Diggers Find Gold

A TUNNEL that paid for itself in gold was completed in the Philippine Islands not long ago. While building an aqueduct to bring water to Manila, diggers encountered a 9,000-foot vein of ore valued at $20,000,000, it is said. Within a thirty-mile radius of Manila are several areas of gold bearing ground.

Rear of one of the new stock quotation boards, showing intricate mechanism which relays electrical impulses from operator's keyboard to moving numbered cylinder dials.



A second type of board installed in a stock broker's office. Beneath each listed stock is a moving paper strip on which are printed the quotations. The operator, at extreme right, posts the quotations as recorded on ticker tape.

Electric "Board Boy" Posts Stocks

IN AN effort to keep up with 10,000,000-share days in Wall Street, electric stock quotation boards have been invented to replace the old hand method of posting, in brokers' offices, the prices at which stocks are selling. The usual method is for "board boys" to post the quotations by hand, as is done in displaying the score at athletic contests. It is slow, lagging far behind the ticker tape, which itself frequently falls behind the active market.

A French war ace originated the idea upon which is based one of two new electric stock quotation boards. The ticker tape passes before two operators in the sending room. They sit at machines that resemble typewriters and, by pressing down keys that correspond to the figures which are printed under each stock on the tape, cause the numbers to appear on the wall board under abbreviations of the stock name. The keys make contacts which cause electrical impulses to shift small rotating cylinders inserted in the quotation board beneath each listed stock. The cylinders are numbered from one through nine to zero, so that the touch of the "typewriter" key causes the correct number to appear.

Keyboard of posting machine, and one of the dial units (above) of the board shown at left.

All stocks whose abbreviations begin with letters in the first half of the alphabet are handled by one operator; all those in the second half, by another. This arrangement increases the speed of the posting, which is said to be limited now only by the speed of the ticker.

From a central sending office, boards all over the country can be operated. In case a broker wants reports on only a few stocks in which his customers are interested, he can cut out all the rest and receive only these by "plugging in" on a device resembling a telephone switchboard.

In the second type of electric quotation board, the operator sits beside the ticker in the broker's office and posts the quotations electrically for the one board, instead of having it operated from a distant sending room. The method of posting the figures also is different. Instead of rotating numbered cylinders, it employs strips of paper on which are printed the changing quotations. Each time a new transaction is recorded, the strip under each stock moves downward from a roll concealed behind the board, and displays in type the latest quotation. The figures are stamped on the strips by printing mechanisms at the rear of the board, controlled electrically from the operator's "typewriter."

Microscope Casts Its Wonders on a Screen

INSTEAD of looking into the eyepiece of a microscope and then making a free-hand sketch of what is seen, with attendant inaccuracies, laboratory workers now can trace the outline of the enlarged object directly from an image thrown upon a sheet of paper. This is made possible in a recent German invention by special lenses and mirrors. Light from a microscope lamp is projected through the glass slide that holds the specimen and up through the microscope to what ordinarily would be the eyepiece. In the new instrument, however, the eyepiece is replaced by glass prisms that reflect the enlarged image to a flat mirror. This, in turn, throws it upon a sheet of paper within a dark-curtained inclosure, in much the same manner as a moving picture image is thrown upon a screen in a theater.

Within the curtained "dark room" an enlarged image of object under microscope appears on screen for tracing.

All the laboratory worker has to do is to trace around the image and he has an accurate enlarged drawing of the object being examined.

Joy and Sorrow Upset the Digestion, Says Expert

WHEN you have just been informed that you are going to get the raise in salary you asked for, don't celebrate by eating a big meal. Likewise, avoid the dinner table right after receiving sad or unpleasant news or while very tired or absent-minded.

Those, in substance, are the "don'ts" issued recently by Dr. Walter C. Alvarez, of the Mayo Clinic, Rochester, Minn., who declared that joy, fear, anger, and all other emotions upset the digestion. They cause the blood to flow to and from the lining membranes of the stomach, which is not fit to perform its digestive function when it contains too much or too little of the vital fluid.

Strop This Safety Razor Like a Straight One

THE latest innovation in safety razors, introduced by Rollin C. Warner, of Albany, New York, is one whose blade can be sharpened, like a barber's straight razor, on an ordinary strop. It is simple in construction and in use has the appearance of the ordinary hoe-type safety razor, yet no special apparatus is required for stropping. The photographs below show the razor being used and the manner of sharpening.

On the side of the blade opposite the cutting edge is a metal tube. When the blade is to be sharpened, the guard and handle are removed and the tapering end

The new safety razor in use, and with handle adjusted for stropping like a barber's straight razor.

of the handle is pushed into one end of the tube, bringing the handle parallel to the cutting edge of the blade. In this position the blade can be stropped or honed like any straight razor.

How Improved Roads Cut Your Motoring Bill

WHEN the roads in your neighborhood are improved, the cost of operating your automobile is lessened by one to two cents a mile. After studying the operating expenses of more than 1,600 automobiles and trucks, the Iowa State College Engineering Experiment Station, at Ames, recently compiled statistics to show the part good roads play in reducing motoring costs.

The figures reveal that when a poor road is changed into a high-class highway, those who use it regularly have 2.06 cents a mile clipped from the cost of driving their cars. A reduction of 1.07 cents a mile results when a bad road is made into a road of fair quality, and .99 cents a mile is saved by improving a fair road to a high type highway.

The same investigation showed that the 1,600 machines ran an average of 11,000 miles a year each, and that their operating cost varied from four to nine cents a mile, depending on the type of machine.

Rare Books on the Screen for All to Read

RARE volumes at the Berlin State Library, Germany, are being reproduced for general use in a novel manner. Each page of the book is photographed with a special camera of extraordinarily small size. Later, enlarged slides, made from the camera plates, are thrown upon a screen for patrons to read. The slides are sent out to various libraries in Germany, so that the contents of the rare books, of which there may exist but a single copy, are made available to many readers while the precious volume itself remains unhandled and preserved.

In making the photographic plates, a rack which holds the book open at the page to be photographed is placed on a table top facing a small camera mounted on a pygmy tripod, as shown in the photograph above. The slide made from the photograph is numbered to correspond with the page number of the book. Thus a reader can "turn" to the page he wants by selecting the slide with the number and placing it in the projection machine, which flashes it upon the screen as long as he wishes to read it or make notes from its contents.

Curious Facts Revealed by Propeller Tests

IN RECENT tests of airplane propellers, Westinghouse engineers found that with a 400-horsepower propeller blowing directly at a large hole in a near-by wall, air cannot get out! Like panic-stricken people in a burning building, the rebounding and eddying air jams the exit. An eight-foot pipe through the wall, projecting four feet on each side, avoids this confusion, and lets out a vigorous blast.

The roar of this propeller test necessitated a noise-proof building. Due to the churning air, the room became nearly two degrees hotter every minute, and at 120 degrees F. ventilation was necessary.

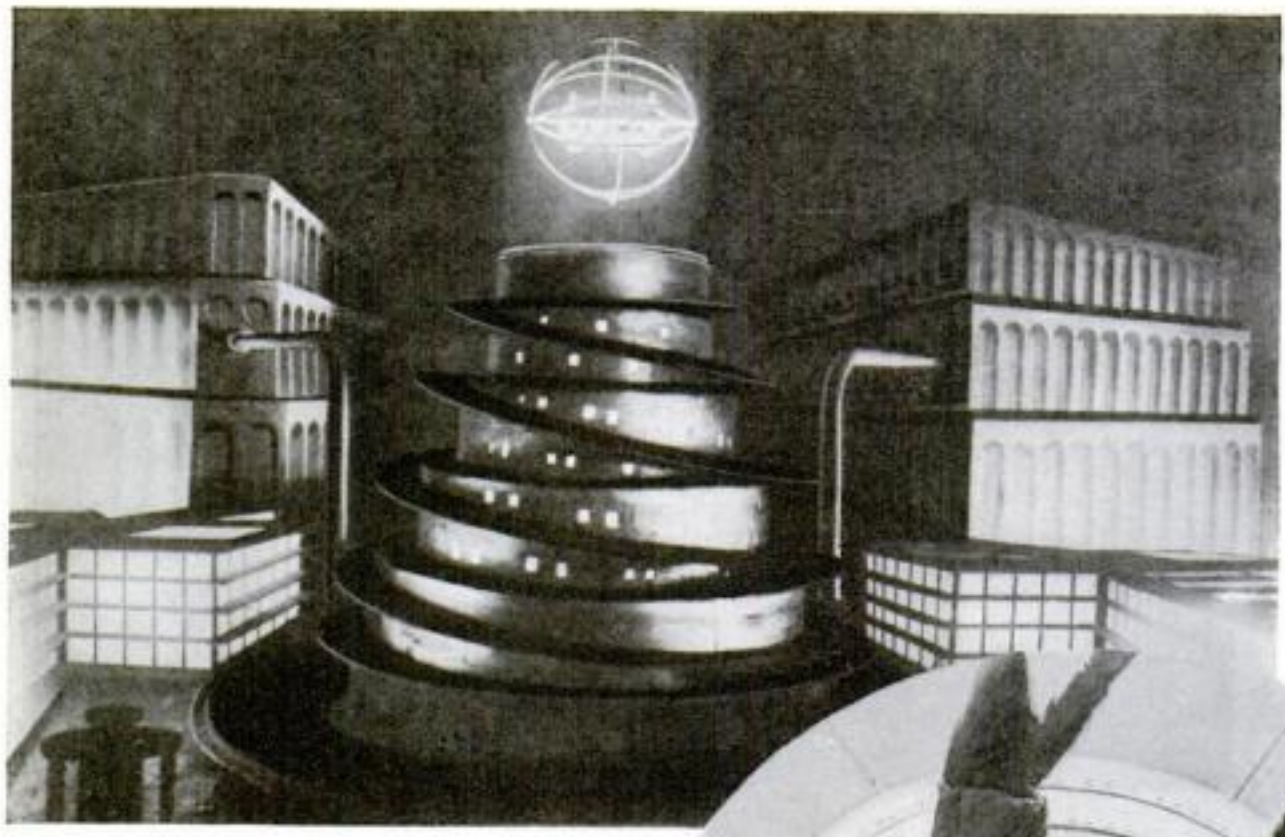
Ten-Pound Radio Transmitter for Airplanes

A MIDGET radio transmitter that weighs only slightly more than a portable typewriter, and occupies less space, has been devised for use of flyers by experts of the United States Coast Guard.

Complete in itself, the baby set weighs less than ten pounds. It is to be put through rigid tests by W. W. Reynolds, Chief Radio Electrician of the Coast Guard, seen examining the little apparatus in the photograph. If it stands up under the tests it will become part of the equipment of coast guard seaplanes so that these "eyes" of the coast patrol can report from the air to their bases during flights, as well as receive instructions by means of receiving sets. In an emergency an S.O.S. and the plane's position can be transmitted to headquarters.

The editor will be glad, wherever possible, to supply the names and addresses of manufacturers of devices mentioned on these pages.

W. W. Reynolds, chief radio expert of U. S. Coast Guard, with ten-pound transmitter for airplanes.



Adventurers in the fantastic gravity-defying airship are pictured in the new movie as walking on the ceiling of the cabin. Above: A view of the strange ship, driven by whirling rings, leaving earth.

Future Trip to the Stars Portrayed in Movies

THE adventures of a celestial Columbus who sets sail into space with two companions in a weird electrical *Santa Maria* form the theme of a motion picture film recently produced in Germany.

The time is supposed to be A. D. 3929, two thousand years hence. The hero of the film story is the inventor of a marvelous spherical airship driven by whirling rings, with which he defies gravity. This fanciful machine, pictured above, contains an air pressure tank to protect the occupants as the machine soars away from the earth's atmosphere on its trip of exploration among the heavenly bodies.

Beyond the range of earth's gravity the passengers find themselves walking on the ceiling of the compartment like flies. Other fantastic adventures befall them but each is said to be based upon known laws of Nature and discoveries of astronomy, giving the story a plausibility that adds to its interest.

Germless Arctic Islands the Healthiest Spot?

IN 1594, more than 100 years after Columbus discovered America, the Dutch navigator Barend Barendsz, still seeking a short cut to the East Indies through the North Polar sea, was caught in the ice off the islands of Nova Zembla in the Arctic Ocean north of Russia. Barendsz and his crew were marooned on the islands for three years and suffered untold hardships from lack of food.

Little did these sturdy sailors dream that the scene of their sufferings was the most healthful spot known in the world. Yet a Russian scientist claims recently to have discovered that Nova Zembla is entirely free of disease-breeding germs.

The investigator, who spent a winter on the islands, tested air, water, dust, and earth without finding one germ. He placed sterile dishes containing agar-agar jelly, a substance considered especially conducive to bacterial growth, outdoors for many hours and then heated them in an incubator. The microbe hunt proved fruitless! A similar experiment conducted for fifteen minutes in any city in the United States would have resulted in the formation of populous germ colonies.

Next came an astonishing experiment. Fresh meat was put in an open jar and placed outside, where it was left for eight months. At the end of that period, there wasn't a trace of putrefaction!

Nova Zembla is an archipelago consisting mainly of two islands. On the southern island live about 100 persons. These people, if all the Russian scientist says is true, should be the healthiest and longest-lived specimens of humanity. But the investigator's report made no mention of the inhabitants. It did, however, recommend the establishment of sanatoriums on the island.

Sonic Depth Finder May Locate Sunken Gold

GOLD, jewels, and other treasure worth millions that lie in sunken vessels on the ocean floor may be located and salvaged with the aid of the sonic depth finder, according to Rear Admiral H. P. Douglas, hydrographic officer of the British Navy.

While the approximate locations of wrecked treasure ships are known, the great difficulty in attempted salvage has always been to find the exact spot. This, the English officer believes, may be done with the sonic depth finder, a device which, by transmitting sound waves from a vessel and recording the time required for them to be reflected back from the bottom of the ocean, determines the exact distance between the surface and any object they strike far below.

Five-Million-Dollar War on Fruit Fly Pest

A FIVE-MILLION-DOLLAR battle is being waged against the Mediterranean fruit fly in Florida. This pest, recently discovered for the first time in the United States, has caused severe restrictions to be placed upon the movement of fruit out of Florida, where infested areas are confined, and where the U. S. Bureau of Entomology has begun a death battle against it.

The fly, itself, is a harmless insect about the size of a house fly. Its habits are cleanly. It lives upon plant juices and "honey dew" such as some insects excrete. But the activity of a large family of grub "children" it produces more than outweighs the good behavior of their parents. Several flies often lay their eggs in the same hole, bored in the skin of a fruit or vegetable, so that as many as a hundred of the hungry grubs hatch out, eating ravenously and growing rapidly. After ruining the fruit or vegetable, they rest as pupae, and then emerge full-grown flies, ready to produce another family of the destructive grubs. The life cycle of a complete generation of the Mediterranean fruit fly often covers less than a month, so they increase rapidly.

First known as a pest in Spain in 1842, the insect spread to all the fruit-raising countries of the Mediterranean, thus gaining its name, before extending its activities to Australia, New Zealand, Brazil, and the Hawaiian Islands. It is most successfully attacked in its adult stage.

New Thermometer Easy to Read

A MERCURY thermometer designed to be read as easily as a watch has been produced through the use of a new kind of bright red glass. The color of this opaque material was found to offer greatest contrast to the silvery gray of mercury. Against the red background, the top of the mercury column can be seen at a glance.

Although the strip of the glass is wider than the mercury column, shields restrict the amount that is visible, so the width of the gray and the red strips are the same. The rising mercury blots out the red. The thermometer in the illustration is designed for use on the boiler of a house heating plant. The new feature also is being applied to hospital and room thermometers.

Mechanical Money Changer "Spots" Counterfeits

THE United States Treasury once paid a high salary to a man who, while counting gold pieces, was able instantly to detect by touch every defective or fraudulent coin.

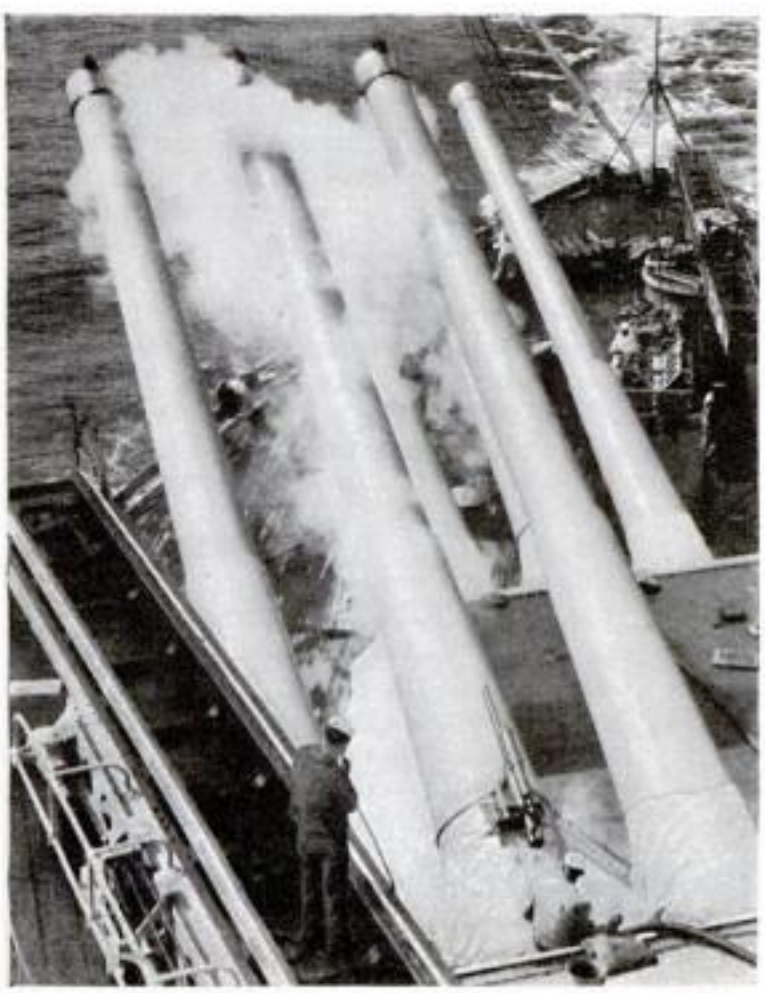
In a candy store in New York City the other day, a robot demonstrated similar infallibility in handling silver quarters. Its business is to turn out five nickels for a quarter and to watch for counterfeit money and worthless slugs.

When a coin is given to the "mechanical man," before it returns the five smaller coins, it automatically weighs the quarter, analyzes its metallic content, and determines if its size is up to standard. As a test, three types of bad coins were offered. One was made of gilded brass, another was slightly undersize, and a third was slightly underweight. Each time, the machine returned the quarters with the request "Please use good coins only" uttered by means of a phonograph record which is set in operation when the delicate mechanism determines that a bad coin has been inserted in the slot.

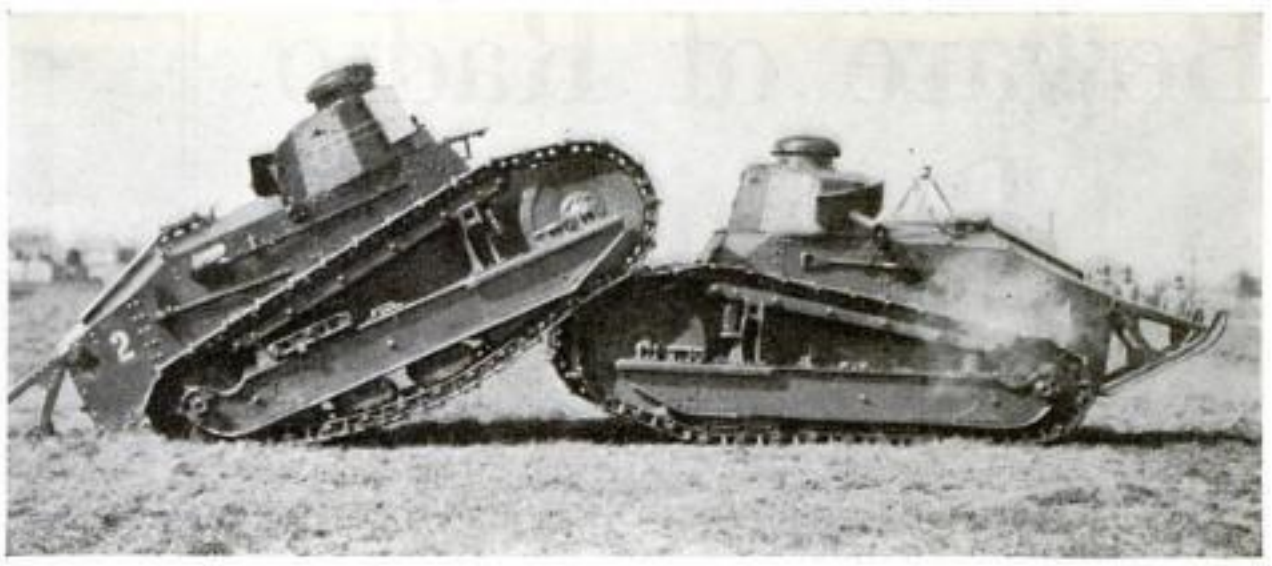
Warship's Long-Range Guns Fire Tons of Steel

EIGHT and a half tons of steel, in the form of screaming shells, leave the big guns on the U. S. S. *California* every time they all are fired together. An unusual photograph of part of the vessel's armament in action was obtained recently during battle practice in the Pacific. The long-range guns were snapped from the bridge as gunners trained them upon a distant target at the rear of the battleship.

To the left of the guns, with a sailor standing upon it, can be noted one of the launching catapults for the swift scouting airplanes with which all battleships of the Pacific Fleet were recently equipped.



Big guns of the U. S. S. *California* in action, photographed from above. Plane-launching catapult is seen at the left.



Army Tanks "Lock Horns" in Butting Battle

WITH clawing endless treads and panting motors, two Army tanks recently fought out a butting contest on the level plain of Miller Field, Staten Island, N. Y. They met in head-on collision during Army maneuvers, and neither would give way. Steel clashed against steel, treads bit into the earth, motors roared, while the two juggernauts pushed and bumped.

At last one reared into the air, astride the nose of the other, and was pushed backward onto the steel skids at its rear so that its treads no longer dug into the ground, and the battle was over. The victorious tank then backed away, lowering its steel antagonist to the ground with a final snort of its powerful motor.

Camera and Tiny Furnace Tell How Fuel Burns

A TOY-SIZED furnace only three feet long and six inches thick, with a mica window in its side, is helping to show the best design for boilers burning powdered fuel. Camera records made through its window reveal just what happens to a burning particle shot through it, according to H. K. Griffin and David F. Smith of the Pittsburgh Experiment Station, U. S. Bureau of Mines, and J. R. Adams, research fellow of the Carnegie Institute of Technology.

The complete track of each burning particle is recorded on the photographic film, which revolves on a drum in the camera. From this chart an observer can tell how long the particle took to burn, and also, through thermometer and gas measurements, how much oxygen it used up and how much heat it yielded. Among the fuels tested so far are coal, coke, and charcoal. Analysis of what becomes of a single speck of fuel in the miniature furnace gives a perfect small-scale reproduction of combustion in a big one, the experimenters say.

Scientists above Par Physically

DOES an interest in science benefit us physically? A reply in the affirmative is suggested by tests covering five years made upon members of the National Academy of Sciences by Dr. Ales Hrdlicka, anthropologist of the U. S. National Museum, Washington, D. C. He took measurements of one hundred of the eminent scientists who belong to the Academy and compared them to the measurements of the population at large.

The results showed, he reports, that the scientists possess an above-the-average physique and a large head, contradicting the old conception of a scientist as a long-haired individual who neglected his body.

Dyed Trees May Give Us Colored Lumber

SCHEMES to dye the sap of a tree so that colored wood will result usually have been classed with trying to cross milkweeds and eggplants to produce eggnogs, or feeding hens ham so they will lay ham omelets. Now, experiments in Maine indicate that the plan may be more feasible than jokers have supposed.

The process followed in experiments recently reported by a chemical organization are as follows: About four feet from the ground, a number of holes were bored in the trunk. Others are bored in three or four of the main roots. All were connected by rubber piping with a dye reservoir, placed twelve feet from the ground among the branches to form a "gravity feed" of the dye to the roots and the trunk.

Throughout the early spring, a constant supply of dye is carried by the sap to all parts of the tree. The process at present is described as expensive, for the average tree requires about six pounds of dye, and the construction of the reservoirs requires considerable labor. But cheaper methods may be devised so that varicolored wood for furniture some day may be produced in this manner on a large scale.

Beware of Radio Bargains!

Veteran Service Man Warns of Gyp Receivers That Lurk Behind Attractive Cabinets

As told to NEWTON BURKE

"Your job," said my new boss, "is to keep the customers satisfied. Fix the sets, but spend just as little time on them as possible."

I STARTED in the radio game through a newspaper "ad" that read: "Radio service man wanted. Fine opportunity for advancement. Must have own car."

I'd played around with radio till I really knew quite a lot about it. I had what passed for a car, so next morning I applied for the job and got it.

My new boss was smooth in manner and a nobby dresser. "Young man," he told me, "your job is to keep the customers satisfied. Don't argue with 'em. Don't tell 'em anything. Just fix the sets so they'll work, but spend as little time on them as possible. I'm selling sets with a free service guarantee, so the more sets you can fix in a day the less the service is going to cost me."

"I'll do my best, Mr. Slade," I replied.

He took me into the back room. It was as bare as a hermit's cave. "This is where you hang out," he said. He seemed to take it for granted that I had all the necessary tools.

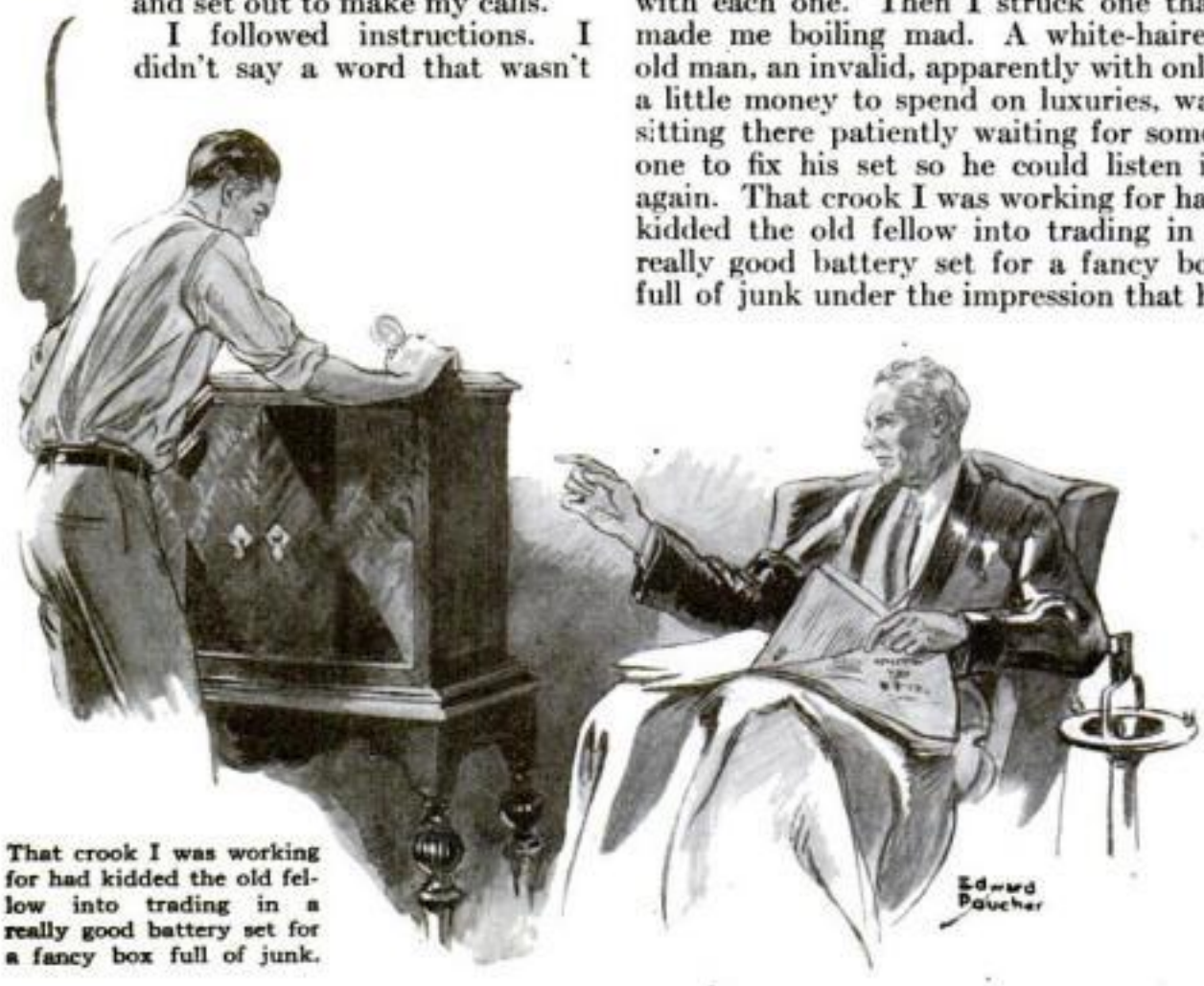
"Now get busy," he ordered, handing me a bunch of service call slips. I sneaked home, chucked a pair of headphones, a couple of screw drivers, a soldering outfit, and some other junk into an old bag and set out to make my calls.

I followed instructions. I didn't say a word that wasn't necessary. But what a lot I found out! The first call took me to a disagreeable old woman who handed me an awful call-down.

"Well it's about time they sent you around!" she rasped. "Here I've paid my good money for a new electric radio set with free service, and do I get the service? I do not! That set hasn't been working for three days."

You can imagine my surprise when I dug into that fancy-looking cabinet and found a shoddy, old-style battery set run by an antique combination A and B eliminator of the liquid type made by some fly-by-night concern. The set hadn't been any good even when it was new, and the eliminator had been in storage so long the connections were all corroded. One was eaten through and when I fixed it the set worked. She was stung, no doubt about that.

THE next few calls were much the same and I became more disgusted with each one. Then I struck one that made me boiling mad. A white-haired old man, an invalid, apparently with only a little money to spend on luxuries, was sitting there patiently waiting for someone to fix his set so he could listen in again. That crook I was working for had kidded the old fellow into trading in a really good battery set for a fancy box full of junk under the impression that he was getting a modern electric receiver!



That crook I was working for had kidded the old fellow into trading in a really good battery set for a fancy box full of junk.

I quit the job. Since then, I've batted around a lot as a radio service man and I'm convinced that you can't get something for nothing. In fact you're much more likely to get nothing for something! A radio bargain set is like any other bargain. It isn't worth a cent more than you pay for it. At best, it's a last year's set with last year's faults.

The main thing in buying a set is to know exactly what you are getting. Don't let a fancy cabinet fool you. It's easy to hide some out-of-date model and a three-dollar loudspeaker behind shiny woodwork.

I'm not saying there are no real radio bargains. Changing styles often throw good outfits on the market at clearance prices; but only the man who knows radio can know a real bargain from a fake, or can analyze the disadvantages of an obsolete set and decide whether the price is low enough to offset them.

THE mere fact that a receiver actually is a full electric set doesn't prove that it's modern. Plenty of early types of electric sets that now are "orphans," with no manufacturer standing back of them, are reposing on shelves waiting for easy-mark buyers.

If you don't know anything about radio, before you buy a set familiarize yourself with the appearance of the latest receivers as advertised by the manufacturers. Note particularly the model or type number, the number and kind of tubes used, arrangement of controls on the panel, and so on. The same reasoning applies to loudspeakers.

Remember that no matter how little you know about the actual functioning of a radio set, nobody can sting you with an obsolete outfit if you know exactly what you want to buy and then insist on getting it.

Two New Tubes—What They Do

Remarkable A. C. Screen Grid Amplifier Offers Undreamed-of Distance, and an Improved Power Tube Adds Volume with Excellent Tone Quality

By

ALFRED P. LANE

Testing internal capacity of new UY-224 screen grid tube, and effectiveness of external shielding methods, in radio laboratory, Popular Science Institute of Standards.

YOU will hear a great deal this fall and winter about two remarkable new radio vacuum tubes. One of these, the new UY-224, is a heater type screen grid amplifier designed to operate directly on alternating current, the heater voltage being two and a half, the same as required by the UY-227 tube. This tube seems destined to revolutionize our conception of what is possible in radio-frequency amplification. Two stages of radio amplification, using this tube, will give as much amplification as can be obtained from four stages using the ordinary 201A tube or its A. C. equivalents, the 227 or 226 tubes.

However, it must be remembered that while two stages of screen grid radio-frequency amplification may be made equivalent to four stages of ordinary amplification, as far as sensitiveness to distant signals is concerned, the screen grid circuit would not equal the circuit using the older tubes for selectivity, because selectivity is determined to a large extent by the number of tuned stages. To obtain the same selectivity with the two-stage screen grid circuit it would be necessary to include extra tuned stages even if no tubes were connected to them.

The other new arrival is the UX-245 power amplifier tube. This tube fits in between the 171A tube, which has been on the market for some time, and the very powerful UX-250 tube introduced last season. Working at recommended maximum voltages, the 245 tube will give as much volume without distortion as the UX-210 tube. And still more important, it accomplishes these results with a maximum plate voltage of 250, only seventy volts more than required for best results with the 171A tube and 200 volts less than the recommended maximum voltage for the 210 tube.

THIS means that by using the new 245 tube it is now possible to obtain a large amount of volume without distortion and yet keep the B-voltages to a point where very expensive filter condensers and rectifiers are not required in the B-eliminator circuit. For instance, the voltage requirement of a 210 tube used singly or in push-pull arrangement necessitates the use of the 281 type rectifier tube. A B-eliminator circuit to furnish the necessary current for a 250 tube used singly or in push-pull must be of the full wave type using two 281 tubes. The necessary voltage and current requirements of the new UX-245 tube are, however, so much lower that it is possible to operate a single tube at maximum voltage requirements from the much less expensive 280 full wave rectifier tube. If the B requirements of the rest of the radio circuit are not too severe, it is possible to operate two 245 tubes in a push-pull circuit, with the necessary current obtainable from a tube of the 280 type.

THE UY-224 A. C. screen grid tube is a logical development from the UX-222 battery-type screen grid tube. Similarly, the UX-245 power tube is a logical development from the UX-171A tube. Figure 1 shows these four tubes side by side so that you can compare them. At the left is the UX-222 battery-type screen grid tube. Next to it is the new UY-224 A. C. screen grid tube. Then comes the 171A tube, and at the right is the new UX-245 power tube. The new A. C. screen grid tube is not merely an A. C. type of the battery operated screen grid tube, but is definitely a more powerful radio-frequency amplifier. In fact, it is at least twice as good as the battery-type tube. This improvement in operation was made possible by the more copious flow of electrons obtainable from the A. C. heated cathode, together with a rearrangement and change in spacing of the elements in the tube.

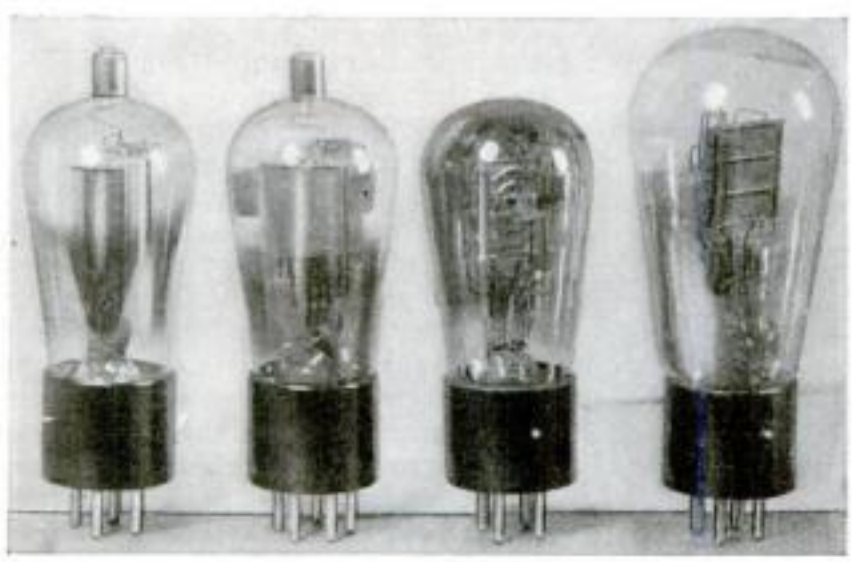


Fig. 1. New tubes compared with old. Left to right: UX-222 battery-type screen grid tube, new UY-224 A.C. screen grid tube, 171A power tube, and the new UX-245 power tube.

IN principle the screen grid amplifier tube of either the battery or A. C. type is essentially like an ordinary 201 tube except for the spacing in the elements and the addition of an extra element in the tube, the screen grid.

To understand the exact functions of the screen grid it is necessary to refresh your memory on the ordinary operation of a standard type tube. You know, of course, that the action of any tube depends upon the flow of electrons sent out from the heated filament or cathode. In the screen grid tube the addition of the screen grid and the spacing of the elements or electrodes makes the plate circuit of the tube of exceptionally high resistance without materially reducing the effect of the grid voltage on the plate current. Therefore, increasing the number of turns in the plate coil will greatly increase the voltage amplification of the circuit. Because of the lower resistance of the plate circuit of the ordinary 226 and 227 or 201A tubes, increasing the number of turns in the plate coil would not prove equally effective, and in practice would not be possible because of the difficulty with regeneration and oscillation effects.

Placing a screen grid in the tube in such a way that it will shield the plate from the grid therefore accomplishes two very important results. First, it reduces the electrical capacity between the

plate and grid and this greatly reduces the tendency toward oscillation. Consequently, all ordinary neutralizing methods may be dispensed with, provided, of course, that the screen grid tube is properly shielded.

This necessity for guarding against oscillation is what cuts down the ordinary tube's efficiency as a radio-frequency amplifier, and if the screen grid accomplishes nothing more than to eliminate the capacity between the elements it will be a worth while improvement. Actually, however, the screen grid accomplishes still more in that it greatly increases the tube's power to amplify signals in the manner already mentioned.

IN THE ordinary radio vacuum tube the flow of electrons is attracted toward the plate because the latter is at a positive voltage. In the screen grid tube both the plate and the screen grid are at positive voltages, the screen grid of the new UY-224 being normally biased at seventy-five-volt positive, with 180 volts applied to the plate.

The peculiar construction of both the battery type and the A. C. type screen grid tube, in which the control grid is brought out to a metal cap on the top of the tubes, is necessary to keep the capacity between the control grid and the plate at as low a figure as possible. You will note from Figure 3 that the screen grid is interposed between the cylindrical plate and the control grid in such a way that the capacity between the two is reduced to almost nothing. In the ordinary vacuum tube where all the leads are brought out to the prongs on the base, at least half of the internal capacity of the tube is due to the capacity between the leads themselves. In the screen grid type the capacity between the leads is almost eliminated by bringing the control grid lead out to the cap on the top of the tube, and the screen grid eliminates the capacity between the elements.

A CONSIDERATION of these factors will show you how important it is to prevent any capacity between the leads outside of the tubes. The entire benefit conferred by the peculiar screen grid construction and the metal cap lead for the control grid would be completely lost if, for instance, the grid and plate leads from the tubes were so placed that there was capacity between them.

The illustration of Figure 2 shows the complicated construction of the elements in the new UY-224 A. C. type screen grid amplifier tube. It is this complicated and delicate construction which accounts for the higher price of the new tube. At the left is shown the complete assembly minus the glass tube. Next to it is shown the elements with the outer section of the screen grid removed, exposing the sheet metal plate. The third view shows the plate removed, exposing the inner screen grid, while the view at the right shows the inner screen grid removed leaving only the control grid and the A. C. heated cathode element. The connection to the plate, the cathode, the screen grid, and the heater filament terminals are brought out to the five prongs on the base of the tube, which is designed to fit into the standard UY socket. The control grid, as mentioned above, is brought out to the small metal cap, cemented to the top of the tube.

Fig. 2. New UY-224 A. C. screen grid amplifier tube dissected to show complicated construction.

In Figure 4 is shown a theoretical wiring diagram of an ordinary 227-type tube arranged as a radio-frequency amplifier, and in dotted lines are shown the additions that make the circuit correct for the screen grid type tube.

BECAUSE of the characteristics of the screen grid type tube, it cannot be used in a regular circuit unless changes are made in the radio-frequency transformer. The number of turns in the plate coil must be increased. If the screen grid tube is used in a circuit with the correct number of turns for the 201A or 227 tube, the amplification obtainable actually may be less than that obtained from the 227 or 201A tube. Thus if you attempt to revise the circuit in a radio receiver you must, in addition to arranging for the new connections to the tube, greatly increase the number of turns in the coil marked L in the diagram of Figure 4, below at left.

To obtain the maximum results from the new screen grid tube it is necessary to pay particular attention to shielding. If you use only one stage of radio-frequency amplification you can get away with practically no shielding. With two or more stages extremely careful shielding must be resorted to. Theoretically, perfect shielding would interpose a metallic shield over the lead wires going to the control grid, and also to the plate terminal of the socket, in such a way that there would be no external capacity between them. Furthermore, the shielding must prevent capacity effect between corresponding leads in different stages.

In a forthcoming issue of POPULAR SCIENCE MONTHLY, probably next month, will appear a constructional article that will show you how to take full advantage of the amplification possibilities of the new screen grid tube by means of practically complete shielding.

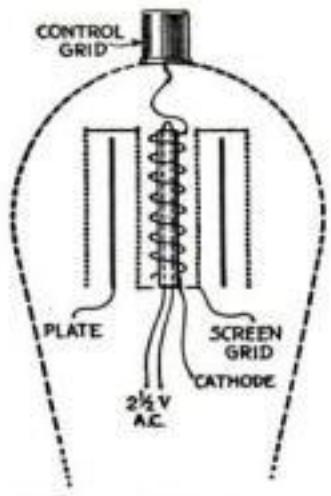


Fig. 3. This diagram shows the arrangement of elements in the new A. C. amplifier tube.

THE current requirements for the UY-224 screen grid amplifier tube are as follows: heater voltage 2.5, either A. C. or D. C.; heater current, 1.75 amperes; plate voltage, 180 volts; screen voltage, maximum 75 volts; grid bias voltage, minus 1.5 volts.

The new UX-245 power tube fits the standard UX socket, but it cannot be used in a set designed for the 171A tube. This is because the UX-245 is designed to operate at two and a half volts on the heater filament and if it is placed in a circuit designed for the UX-171A tube, where five volts are applied to the filament, the tube will be burned out at once. The filament current of the tube is one and a half amperes. The plate voltage is 250 maximum, and the grid bias voltage should be minus fifty volts. It is possible, therefore, to use the UX-245 tube in any receiver designed for the UX-171A provided the filament current is reduced in voltage to two and a half, but owing to the high filament current it is not a good tube to use in a battery type set unless a separate A. C. filament heating transformer is used to supply the filament current for the UX-245. It will operate with satisfactory results on 180 volts on the plate, in which case the grid bias voltage should be minus thirty-three. The plate current of the UX-245 is thirty-five mils as compared with a maximum of twenty mils for the UX-171A.

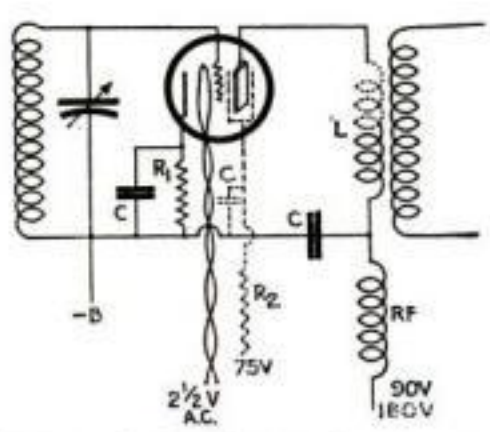


Fig. 4. Wiring diagram showing essential parts of a radio-frequency amplifier. Dotted lines indicate changes in using screen grid tube.

IF YOU already own a radio receiver using the UX-250 power tube in the last stage of audio amplification, the UX-245 tube is of no particular interest to you as you are already using a tube having a greater power handling capacity than the new tube. The same reasoning applies if you have a receiver using a UX-210 tube. However, if you are considering the purchase of a new receiver, choose a set designed to handle the UX-245 in preference to the UX-171A. Of course, if the receiver you are considering is equipped with two UX-171A tubes in a push-pull circuit that is another story, for two UX-171A tubes operating in push-pull will deliver more undistorted power than a single UX-245.

Timely Kinks for the Radio Fan

Plugging in the Short-Wave Set

How to Make a Simple Adapter Connection from an Old Tube Base—Current on the Farm—B-Eliminator Facts

ONE of the simplest ways to connect a short-wave receiver to your regular broadcast set, so as to make use of the audio amplification in the latter, is to construct a special adapter plug which can be placed in the detector tube socket of the broadcast receiver in place of the detector tube.

This special plug can be made easily from the base of a burned-out tube. Wrap the old tube in several thicknesses of cloth, place it on the workbench, and break the glass with a hammer. The function of the cloth, of course, is to guard against flying glass. Remove from the base all of the glass fragments, as well as the cement that held the glass tube in place. To remove the fine wires attached to the tube prongs, grasp each wire in turn with a pair of pliers and touch a hot soldering iron to the soldered connection at the tip of the prong. This will soften the solder and you can pull out the wire. Replace these wires with the new leads which are to be connected to the short-wave adapter unit, and solder them to the prongs.

Since the prongs on the base are not marked, the simplest way to determine which is the grid prong, and so on, is to place the base over a socket and note the markings on the socket which indicate the connections.

Using pliers and a soldering iron to remove the wires from the prongs of burned-out tube base.

How to Use 32-Volt D. C.

IF YOU are located on a farm where the only source of electric current is that from the battery-operated farm lighting plant, there are two ways in which you can use the thirty-two-volt current to operate the filament circuit of a battery receiver.

The simplest and most satisfactory method is to tap into the battery itself, using three cells. However, if the farm lighting outfit is at some distance from the house this is not practical, because very large wire would be required to obtain the full six volts for your receiver. Under such conditions the best method is to use the full thirty-two-volt potential with a variable resistance to reduce the flow of current.

If your receiver is of the standard five-tube type, it requires a current of one and a quarter amperes. A rheostat to handle this current on a thirty-two-volt circuit should have a resistance of not less than twenty-four ohms, with a current-carrying capacity of not less than one and a quarter amperes. The simplest method of control is to connect the rheostat in series with the drop wire that you plug into the light socket. Turn the rheostats in the set full on and connect a high-grade voltmeter permanently across the A-battery wires inside the radio set. Always place the plug in the electric light socket with the rheostat turned so that the full resistance is in the circuit. Then gradually turn the rheostat until the voltmeter reads exactly five volts. You will notice that practically all of the resistance must be in the circuit when the battery is fully charged and that the rheostat must be turned to maintain the full five volts as the battery runs down. Special rheostats suitable for this service are sold by most radio supply houses.

The same system, of course, can be used on a 110-volt farm lighting circuit. A suitable rheostat for such service should have a total resistance of not less than eighty ohms and a current carrying capacity of one and a quarter amperes.

A B C's of Radio

OFTEN it is difficult to locate a mistake in wiring a receiver after the work is completed. You may check the actual wiring against that shown in the blueprint diagram a half dozen times without finding the error. And yet the fact that the receiver refuses to work is positive proof that something is wrong either with the wiring or with some piece of apparatus.

If you encounter trouble of this kind, fold up the blueprint and put it away. Then, on a large sheet of paper, make a rough but accurate wiring diagram, working directly from the receiver. Then, get out the original blueprint again and check it against the drawing you have made.

Very frequently, by means of this method, the mistake is immediately apparent.

B-Eliminator Condensers

IN THE standard filter circuit of a B-eliminator three condensers are used. One is connected directly between the positive wire and the negative wire before the first choke coil, the second between the two choke coils, and the third across the line beyond the second choke coil.

All of these condensers have a definite effect on the filtering action of the circuit, but they are not exactly alike in their action on the hum. The first condenser has little action on the hum but great effect on the final voltage produced. The larger the first condenser, the greater the final voltage and also the greater the strain on the rectifier tube. The size of the middle condenser is of most importance in determining the amount of hum produced. The larger the condenser, the less hum you get. The size of the third condenser has some effect on the amount of hum but has a greater effect on the tone quality of the signals. A relatively small condenser here will not seriously increase the hum but will result in poor tone quality. The third condenser acts as a storehouse for the current drawn by the plate circuit of the power tube and must be large enough to supply the instantaneous demand for relatively large amounts of current required to reproduce the low notes.

Solder or Binding Posts?

SO FAR as operating results are concerned, it makes no difference whether you wire your receiver with solder connections or use binding posts, provided you make a solid joint. Radio fans who have never tried a soldering iron seem to think it takes longer to make solder connections. If the instruments are fitted with soldering lugs this is not the case. Usually it takes less time to solder a wire to a lug than it does to form a neat loop in the wire, remove a binding post nut, fit the loop over the screw, and replace and tighten the nut. Furthermore, it is always more difficult to cut a piece of wire to the proper length if you have to allow for loops at each end than it is if you simply have to make connections to a soldering lug.

Design selected by the Kerseys for the home they plan to build. Their problem is to choose the best materials. Courtesy The Home Guild of America, Architects.

Lining *the* Rooms *of Your* House

A Wide Variety of Good Wall Materials Are Available to the Home Builder—An Expert Helps You to Choose

ARE you, too, planning to build a home of your own? In this article, one of an entertaining series, an expert gives valuable advice on how to select the best materials to assure beauty, comfort, and durability. If you have some special problem, Popular Science Institute will be glad to help you solve it. Just write a letter to the Building Service, Popular Science Institute, 250 Fourth Avenue, New York City.

By ROGER B. WHITMAN

"NOW can we talk about what we are going to do indoors?" asked Mrs. Kersey. With her husband she was paying a third visit to the architect's office, getting his expert advice on plans for their suburban home. "Of course, it has been interesting to find out how the outside walls and roof should be made, and I've enjoyed it; but I'm crazy to get to work on the plans for inside. I want a white Colonial dining room, and the living room is to be oak with beams across the ceiling. The kitchen is to be tan and blue, and—"

"Here now, don't go so fast," broke in the architect. "You can't decorate your walls before you build 'em, you know, and that's what I want to see you about."

"Well, what is there to the walls?" inquired Mrs. Kersey. "They're plaster, aren't they? And that's just—just—put on, isn't it?"

"Yes, but you can't put it on air. So far, your walls are only a frame of studs sixteen inches apart, and they have to be covered with something to put the plaster on. The question is, what is that something to be? You see, plaster has no strength, and when it's in a thin sheet on a wall, it can't even stand up by itself. It isn't sticky, so it won't hold on wood. The commonest way to put it on is to nail wood lath across the studs a little distance apart, and to spread a thick mixture of plaster on them with enough force to shove some of it through. The plaster that goes through will bulge and droop down over the back, and when it hardens it acts as a hook that binds the plaster to the lath. The same idea holds true for metal lath, but that is full of little holes, and the plaster gets more of a grip. And metal lath won't burn. Another way is to line the walls with sheets of material porous enough for the plaster to cling to; little threads of plaster work into the pores, and when they dry the plaster surface is there to stay.

"But what are your ideas about decoration? It may be that in some rooms you won't use any plaster at all. Are you planning to finish with paint or with paper?"

"Wall paper in the bedrooms and in the dining room," said Mrs. Kersey. "In the living room I want scenic paper in panels with moldings around them, and the rest of the walls painted. The library should be paneled in oak, I think, and of course the bathrooms should be tiled."

"That's something to start on. You'll want plaster under the wall paper, so we can settle on how you want it put on."

"Does it make any difference?"

"Not in appearance. But there'll be a difference in cost, and in permanence. Wood lath will be the cheapest, but it'll move with the settlement of the house, and the plaster will crack. Metal lath costs more, but has much greater strength. It comes in big sheets that are put on with the edges overlapping, and being steel, it won't distort enough to crack the plaster unless the settlement is much worse than it should be. It should be used wherever there are expensive decorations as a sort of insurance against damage—in the living room, dining room, and the entrance hall. When people can't afford to use it over the whole room the next best thing is to put it in the corners. That's where cracking usually begins, and strips of metal lath bent to fit will do a lot to hold things together.

"But with any kind of lath you'll have to wait a couple of weeks or maybe a month for the plaster to dry, before you can decorate, and that's something to think about. There's the chief advantage in using plaster board; you can decorate as soon as it's up."

"Plaster board?" inquired Mr. Kersey. "What's that?"

"IT'S plaster cast in sheets at the factory and covered with tough paper for strength. It's wide enough to stretch over three or four studs, and goes from floor to ceiling. Joints between the sheets are filled with special cement, and covered with paper-thin strips of perforated metal. The joint is so smooth that when it's papered or painted you can't see it. Plaster board hasn't the strength of lath and plaster, but it can be stiffened by giving it a coat of plaster. And there's a new material that's even better. It's like plaster, but is much harder and stronger, so that one coat will make plaster board or wall board as stiff as you could want it."

"Now you're springing another new one," broke in Mr. Kersey. "What do you mean—wall board?"

"You might call it artificial wood," responded the architect. "It's made of wood fiber or some other vegetable fiber ground up and pressed into boards one eighth or one fourth inch thick and four feet wide. The fibers run every which way, so there's no grain. Some kinds are compressed so hard they're almost like wood; you can nail them to the studs and have a finished wall ready for painting. They're not so good for papering, because there's no way to make a smooth joint between sheets that won't crack and show through; but you can nail moldings over the joints that will divide the wall or the ceiling into panels, and with painting you'll get a mighty pretty effect that would be hard to beat.

Applying porous wall board as a base for plaster. Thicker than plaster board, this material is a sound deadener as well as a good heat insulator.

"Other kinds of wall board, not compressed so hard, are porous enough for plaster to bind to them. They're put up with the same kind of joints as plaster board; strips of perforated metal or insect wire bedded in cement. Those porous wall boards are thicker than plaster board. They are sound deadeners, and good heat insulators, too."

"Did I understand you to say that one kind of wall is fireproof?" asked Mrs. Kersey.

"That's metal lath and plaster; but I didn't say fireproof—I said fire *resistant*. That is, it is better able to keep the wood behind it from catching than the others."

"That's what I want, then. Fire is the one thing I'm afraid of. Will you put metal lath behind the paneling in the library, too?"

"NO, THE wood is nailed directly to the studs. But if you want to make that room fire-safe, there's a kind of paneling made of cement. It is so exact an imitation of carved wood that the first time I saw it I had to dig it with my knife before I could believe it was anything else. It has the grain and the color, and you can get it in practically any pattern you want."

"Put us down for that, then, and the downstairs rooms are all settled."

"Oh no, they're not. How about the kitchen? Have you thought of having that tiled?"

"No, I haven't," responded Mrs. Kersey. "Would you put tiles all over?"

"Yes, if you're willing to stand the expense, and to my mind it's worth while. Glazed clay tile won't absorb grease and smoke, it is easily cleaned, and will keep the kitchen fresh and bright."

"That sounds fine, and I'd like it—if we can afford it. Is there anything else we might use?"

"Oh yes. Any finish that's hard and smooth will do; something that grease won't cling to—enamel, for instance. You could use enameled plaster, but it's better to have something harder. You can make the walls of sheets of cement and asbestos; that is hard as a rock. The sheets are nailed to the studs or over plaster board or wall board, and they come already enameled and divided to look like tiles. You could use that in the bathroom, too; it's waterproof."

"NO, I'VE set my heart on a tiled bathroom," said Mrs. Kersey. "By the way, how are tiles put on? Are they nailed?"

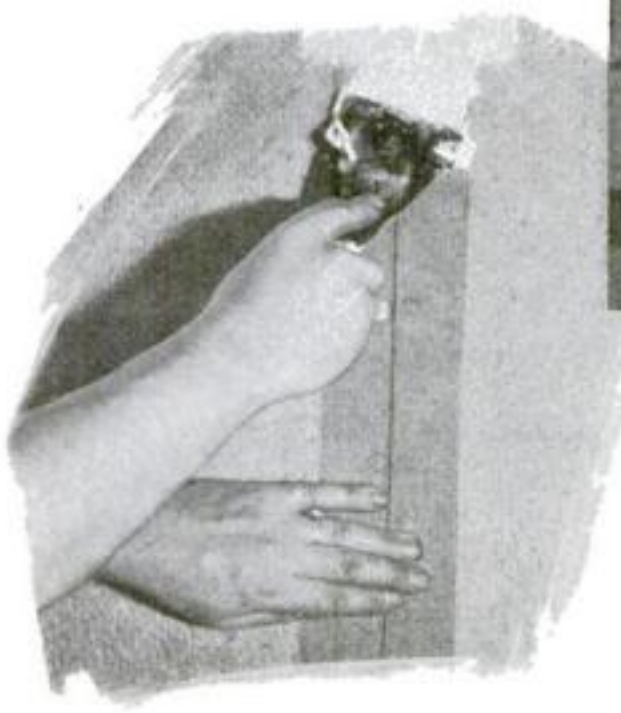
"Heavens, no! You can't nail a piece of china, and that's practically what tiles are. There's a backing of metal lath and cement plaster, and the tiles are cemented to it. They are put on one by one. Have you decided on the color?"

"I've been dreaming about it for months. The walls are to be dark green at the bottom, shading through light green to white at the top and the ceiling. It's to look like the bottom of the ocean, you see."

"With the bathtub hollowed out of a chunk of coral, I suppose?" the architect laughed. "But seriously, that should look good, especially if you use tiles that are not evenly colored. You can get them with wavy surfaces and in shaded tones, to avoid monotony. Any large wall surface that's the same all over is uninteresting compared with one that has high lights and shadows, and that changes with the lightings. Take your living room, for instance, where you say you want panels of scenic paper with painted surfaces between. Don't have those surfaces dead flat and of even colors. Either make them rough, or stipple them in two or three colors to give texture and interest. But don't go too far the other way. Don't make the walls so rough or of such staring colors that they kill everything else.

"Did you (Continued on page 133)

An unusually attractive example of the modern tiled bathroom. The tiles are cemented to a backing of metal lath and cement plaster and fitted one by one.



Left: Wire cloth bedded in plaster makes a neat, noncracking joint between sheets of wall board or plaster board. This photo shows how it's done.

Applying the first coat of plaster on metal lath. Some of the plaster, forced through many small holes, binds the rest firmly to the lath.

Newest Household Devices

Cooking foods in their own steam is made easy by a new waterless cooker that prepares a whole meal at a time. The lower picture shows the heavy bottom of three layers—two of aluminum, with asbestos between—to prevent scorching.

Here's a sanitary new way of disposing of kitchen refuse. Paper bags are held open by a metal frame. When a bag is full it is closed by a draw string and thrown away.

Open the bottom of this novel two-door laundry hamper, and the clothes tumble out. There's no need to fish for clothes wadded in the corner. Garments to be laundered go in the top door.

This five-watt night lamp for nursery or sick room goes on when the main light above it is switched off. The drop cord which suspends the lamp screws into any socket.

A new type of base for pots is said to convert any covered saucepan into a "waterless cooker." Placed over a gas flame, it forms an air pocket beneath the pan and prevents scorching. The heat is comparable to that of a double boiler.

Beauty and utility combine in this prize-winning kitchen sink designed by a University of California art student. Note spacious table areas, convenient drawers, and cupboards.

DOES some part of housekeeping cause your wife worry or drudgery? Maybe she needs one of these inventions.

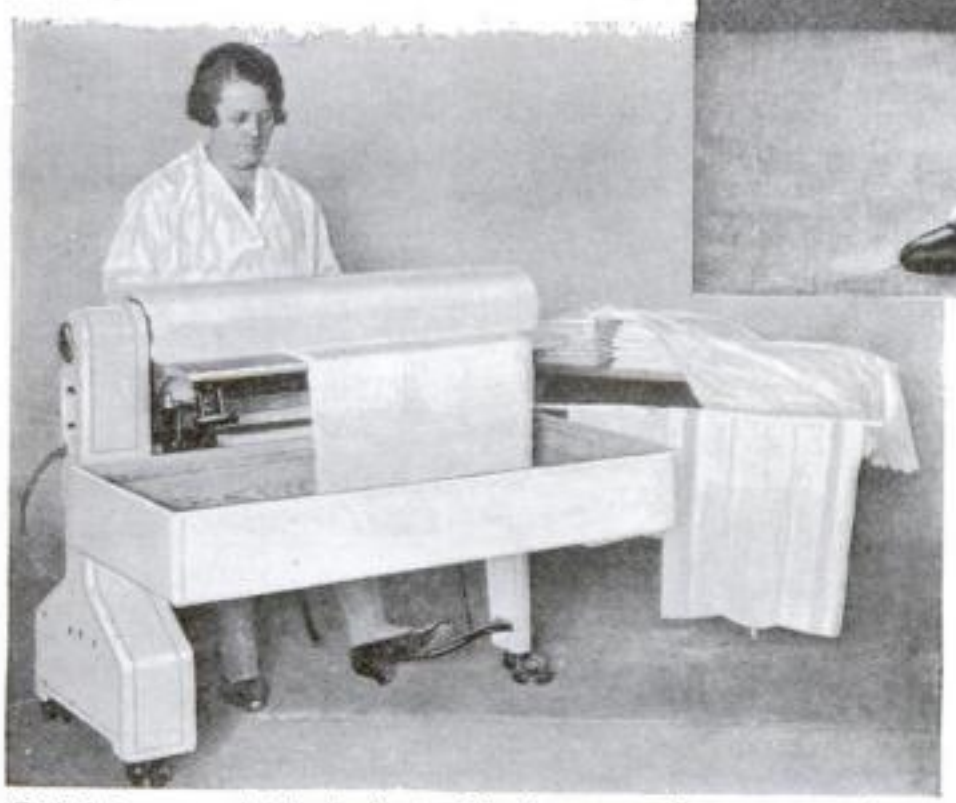
Twin labor savers for the kitchen are a new can opener and knife or scissors grinder, interchangeable in a single wall bracket. The can opener will remove the lids of round, square, or oval containers.

The same device with grinding wheel attachment in place. Scissors are sharpened on a special small wheel at the side, while knife blades are given an edge in groove at center.

A convenient kit for handling and filling baby's bottles. It holds seven, sterilizes them all at once, and supports them for filling.

This hinged bracket makes easy work of hanging clothes from a window. Bracket, pulley, and line swing into the room. No need to lean out.

Toasted sandwiches can be made in short order with this up-to-date aluminum electric grill. It turns out one a minute, and adjusts itself to any size, from paper-thin to thick-sliced sandwiches.



Built into a new electric ironing machine is a convenient tray to receive the ironed articles. It facilitates greatly the handling of sheets and other large pieces, and it gives the ironing machine the utility of a table as well. The entire equipment rolls on casters, so that it can be moved easily to the most convenient location, where it is plugged into a wall socket.

Made of waterproof fiber, this remarkable kitchen apron cannot become damp or soggy, according to the maker. It also resists grease.

Turn the crank, and you have potato chips. Simply place a potato into the convenient holder of this machine and a revolving cutter does the rest. It also slices carrots and onions.

Your *Motorized* Workshop

How to Use It Expertly in Making a Colonial Footstool or Other Small Pieces of Furniture

By WILLIAM W. KLENKE

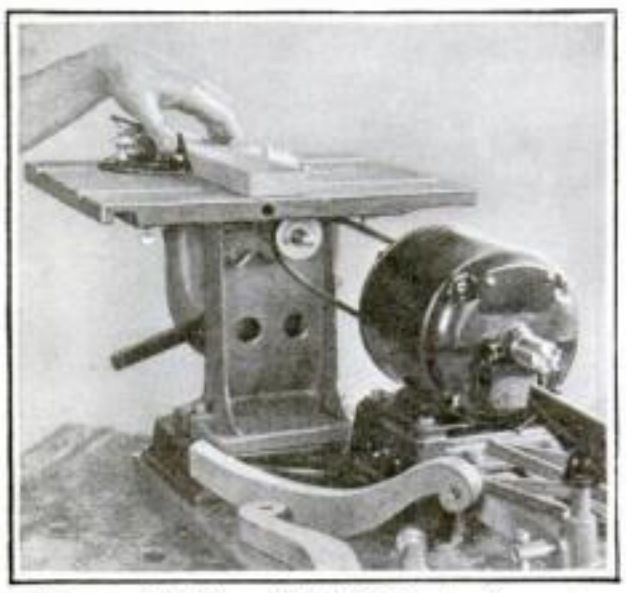
Author of *Art and Education in Wood-Turning*

WHEN I was a boy of fourteen it was a treat for me to visit my chum's home workshop and try my hand at turning some simple "whatnot" on a homemade foot-power lathe. Today many splendid small woodworking machines are available. All one has to do is to turn on the electric switch to experience the expert's joy of creating beautiful and useful things from wood.

It is my purpose in this and following articles to show the amateur how to make beautiful, useful, and substantial pieces of furniture almost entirely with these motorized home workshops, and do it more easily and accurately than by hand.

The first project, a footstool of Colonial design, allows a variety of machine operations to be learned. Obviously, any similar small piece of furniture will involve the same methods.

Mexican mahogany is an excellent material to use for the visible parts, al-



How to hold the rails (sidepieces) when cutting them to exact length on the circular saw.

though other woods such as birch or maple may be substituted and stained to imitate mahogany, if desired.

Step No. 1—Getting Out the Stock for the Rails. On the circular saw cut the four rails (two side and two end pieces) to the approximate sizes to make it easier to handle them on the planer. Pine or whitewood will serve for them if they are to be covered with upholstery. Plane one surface smooth and true and mark it with an X on all pieces to indicate the working face. Hold this face against the planer fence and joint (plane) one edge smooth and true. This edge on each piece should be marked with an X to identify it as the working edge.

On the circular saw hold the working edge against the fence and rip all pieces to the width of 2 1/16 in. (1/16 in. being allowed for planing). In like manner cut the four

Colonial footstool made by Mr. Klenke to demonstrate how small woodworking machines are used.

MACHINERY is remaking all our home workshops. More than anything else, the introduction of compact, efficient, and reasonably priced woodworking machines has helped to popularize the hobby of making things with tools. Why? Because machines lend new zest to the work, they take away the drudgery, and they make it possible for the beginner as well as the trained craftsman to turn out satisfactory projects.

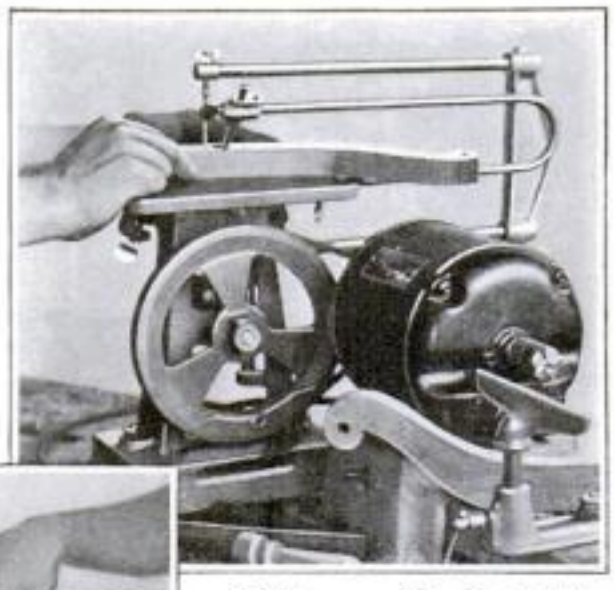
In a series of articles, of which this is the first, Mr. Klenke will demonstrate in detail how to operate both combination and individual machines. Through the courtesy of various manufacturers, he will illustrate the use of many machines that have been approved by the Popular Science Institute.

pieces (if necessary) to the thickness of 13/16 in. (1/16 in. extra for planing). Now cut one end of each piece square. Adjust the guard to get each pair of pieces exactly the same length, and cut the other end of each. Plane the remaining surfaces and edges smooth and true on the planer.

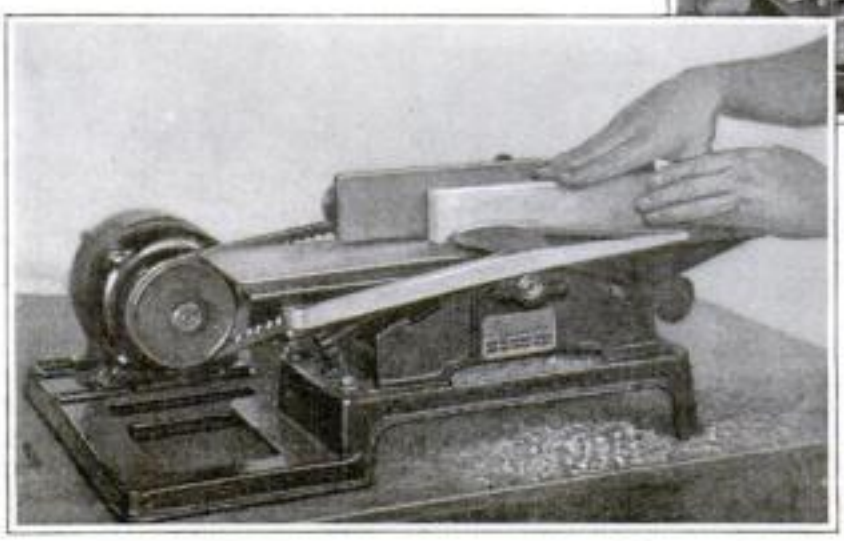
Step No. 2—Legs. Draw and cut out an accurate cardboard pattern. Use it to mark the wood. To avoid splitting, bore 3/8-in. holes for the handles or cross spindles before sawing the curves. On the jig saw cut the design out carefully, keeping just outside the lines. Be sure to make "safety" cuts in the waste stock where necessary to avoid having to back out the saw at acute corner curves and perhaps cause the blade to break.

Step No. 3—Spindles. The stock should be 1 1/8 by 1 1/8 in.; this allows 1/8 in. for truing up on the lathe. Locate the center of each end by drawing diagonal lines. Bore small holes to receive the points of the lathe centers. Rough the corners off with a gouge and then turn to the largest diameter. Next cut down a short distance to give the exact length from shoulder to shoulder—8 in. Turn the spindle to the design and sandpaper it in the lathe. Turn the dowels at the ends to exactly 3/8 in. in diameter and 1 1/8 in. long, and as you cut the work free, round up the ends with a small skew chisel.

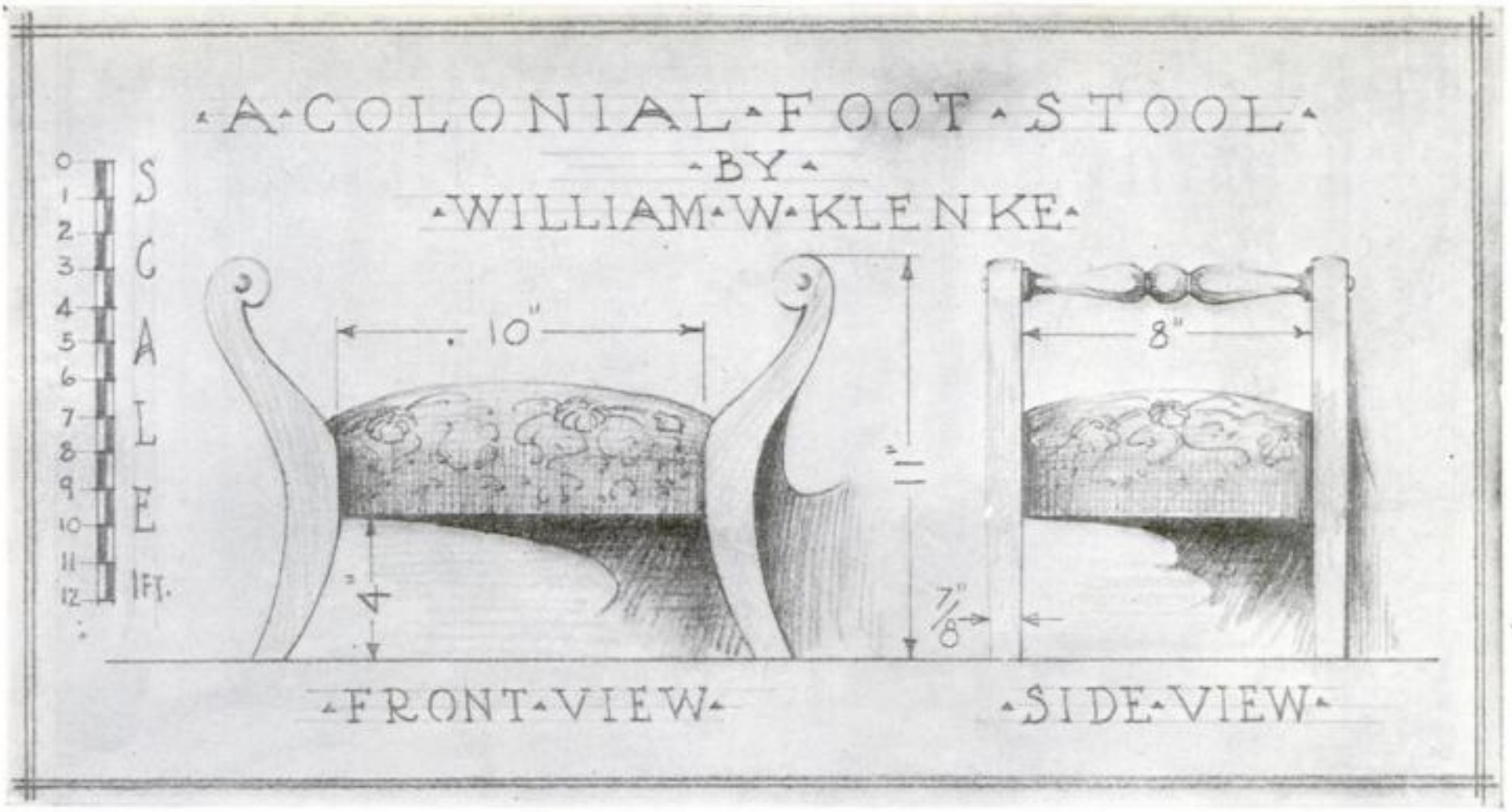
Step No. 4—Sandpapering. On the disk sander true up and smooth all flat surfaces and convex curves. For concave



Cutting one of the footstool legs on the jig saw. Note the rod and adjustable foot which holds down the stock on the table.



One face of each piece is planed; then this face is held against the fence or guide of the planer and one edge is jointed (made true) as shown at the left. The position of the hands is important. A swinging guard presses against the wood and covers the cutter.

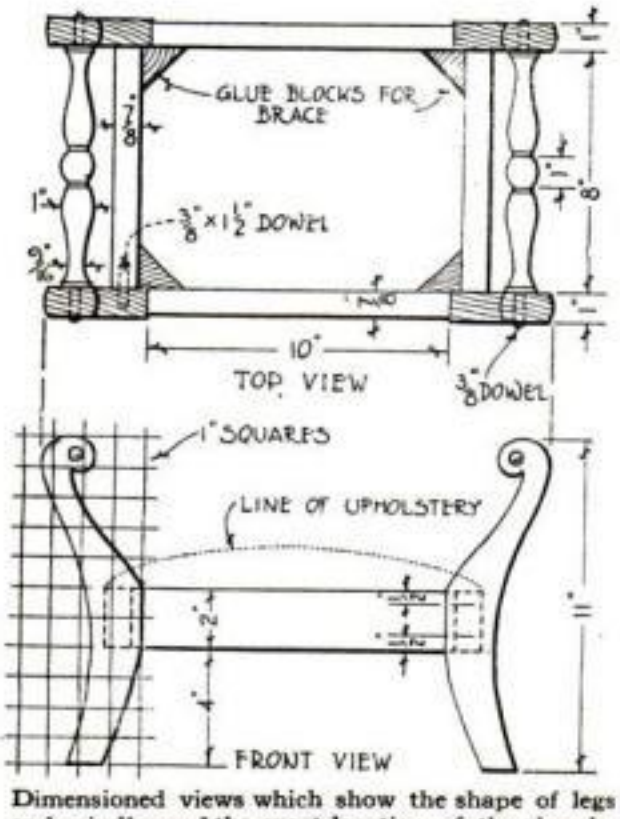


Mr. Klenke's original pencil sketch of the footstool, made as a preliminary to illustrating the various steps in machining the parts. For details, see the drawings in the lower left-hand corner.

curves use a drum sander, if available; otherwise turn a cylinder to 3 in. in diameter and fasten a sheet of No. 1½ sandpaper to it.

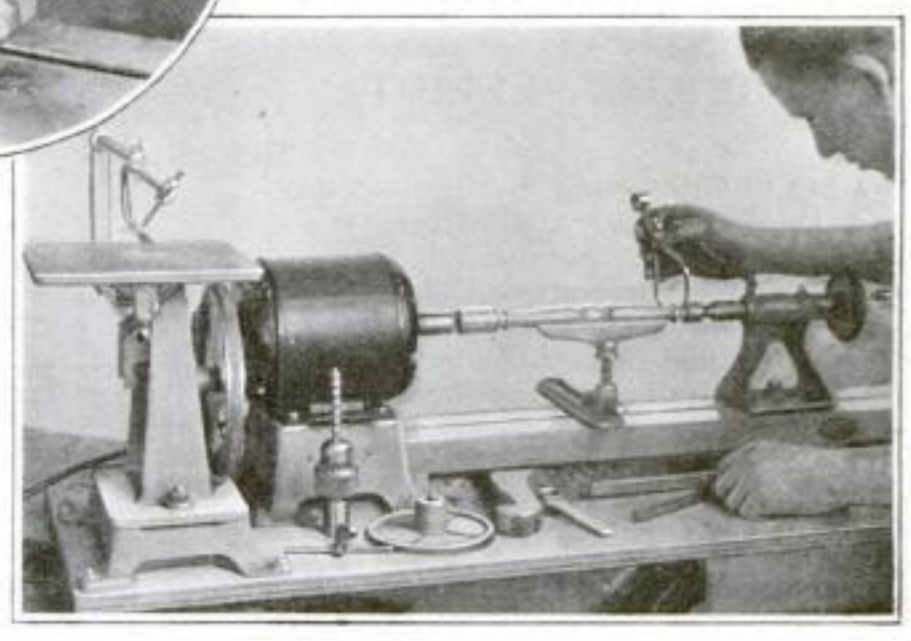
Step No. 5—Joints. Locate accurately all centers for the dowel holes—two in each end of each of the four rails and corresponding holes in the legs. By means of the lathe and a chuck, bore all the holes. If you use a short auger dowel bit, which is advisable, first file off the threads on the point (leave the point itself) to prevent the bit from pulling too fast.

Step No. 6—Assembling. Make a trial fitting of all parts between clamps but without glue. Mark the joints of mating members No. 1 and No. 1, No. 2 and No. 2, and so on. Two separate gluing operations are necessary. First glue the long rails and legs together. Place a scrap of wood under the clamp to avoid bruising the legs. Put plenty of glue into the holes and on the dowel pins; then clamp the work together lightly. Use only a liquid glue of the best quality or a tested brand of flake hide glue. Sight across the legs for any twist. Allow at least five hours for the glue to dry.



Dimensioned views which show the shape of legs and spindles and the exact location of the dowels.

Cleaning up the convex curves of the legs on a drum sander. If this type of sander is not available, a sanding cylinder can be turned from wood, the edges of the sandpaper being held in a groove with a small strip of wood; the roll is used in the lathe.



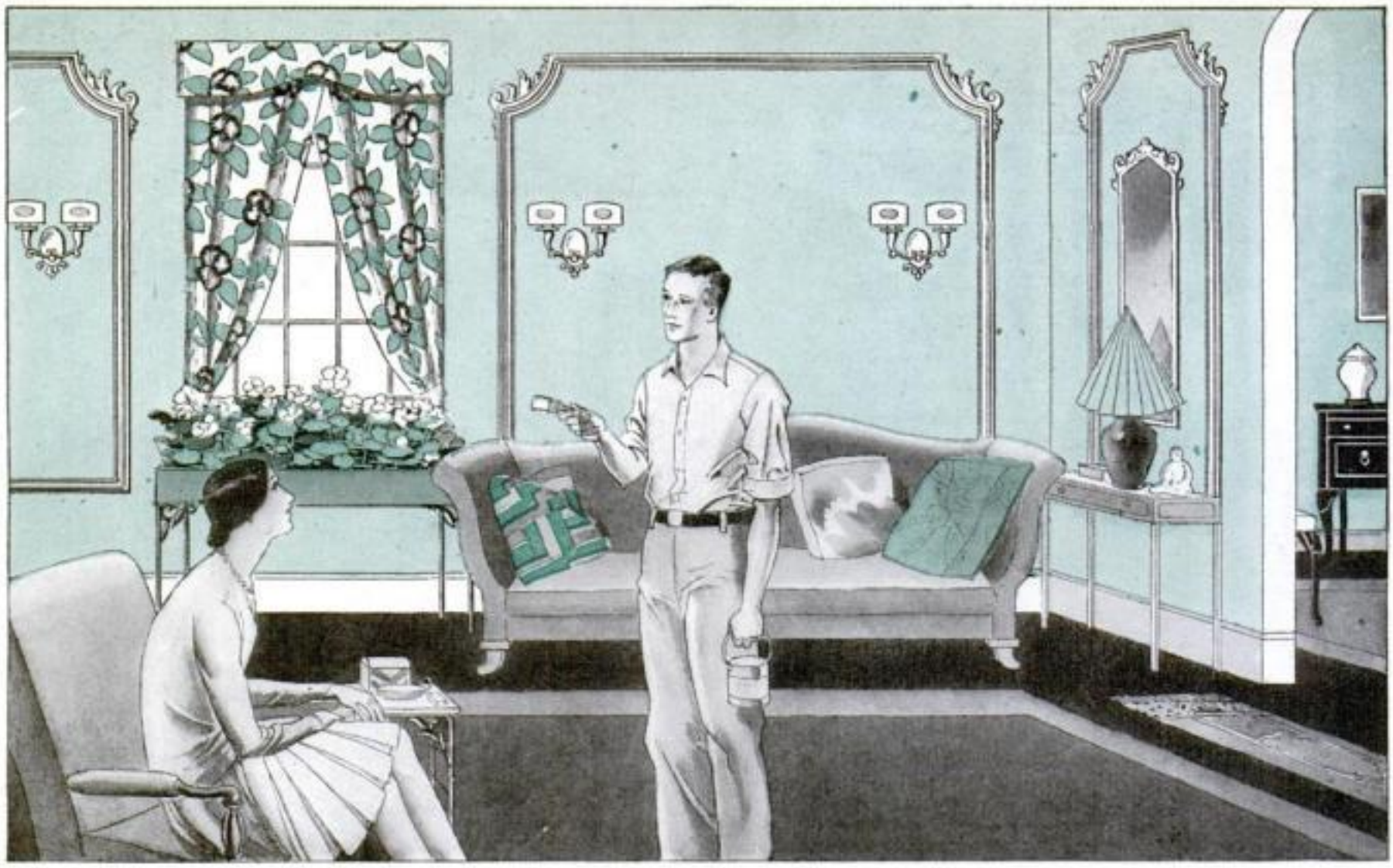
The spindles or handles in the lathe. Calipers are used to make measurements. Note the stock left for dowels at each end.

Next assemble the project completely, being sure that all four legs rest on a true surface, that the frame is square, and that the tops of all rails are in line. It is a good idea to have some fine sawdust on hand when gluing to sprinkle over the glue that oozes out; this will absorb it sufficiently to allow it to be peeled off like gum immediately afterwards with a chisel. When the glue has set, glue the corner blocks in place

Step No. 7—Cleaning Up. Remove all excess glue with a sharp chisel, cutting, wherever possible, across the grain. Sandpaper thoroughly all parts with No. ½, 0, and 00 paper, rubbing with the grain. Round the corners slightly.

Step No. 8—Finishing. There are many ways of finishing mahogany. One of my favorite methods is as follows: Buy a high-grade mahogany water stain powder and dissolve according to directions, or obtain a prepared wood stain or dye of first-class quality. Use liberally and let it dry. Brush on very thin white shellac and sandpaper when dry with No. 00 paper. Apply two coats of paste wood filler, following the directions on the can. Allow at least two full days for the filler to harden. Apply three thin coats of white shellac, rubbing each coat when dry with No. 00 sandpaper, and the last coat with crude oil (or light machine oil) and fine pumice stone powder. If you have a spraying outfit, spray clear lacquer on instead of shellac.

The selection of a covering and the method of applying the upholstery is a matter of individual choice.



You can duplicate some of the finest effects of professional decorators by paneling your living room walls with specially prepared and easily applied moldings.

New Ornaments *for* Your Home

Ways to Use the Ready-Made Carvings and Moldings Now Available for Walls, Woodwork, and Furniture

By BERTON ELLIOT

AMATEUR decorators now have at their disposal a wide variety of ornamental carvings, moldings, and relief decorations. These have been placed on sale in many of the larger paint stores and painter's supply houses throughout the country, as well as in some of the more up-to-date smaller paint stores.

Applied carvings have been used in furniture factories for years, and relief decorations have been employed to a considerable extent in public buildings, clubs, and fine residences. Ready-made decorative materials of this kind, however, have never before been generally available to the home decorator.

This form of decoration, which is new to most home owners, provides thickness in addition to length and breadth and therefore gives a depth and richness of appearance that cannot be obtained through flat surface decoration. It produces high lights and shadows with their ever interesting and changing effects.

There are two distinct types of relief ornaments on the market. One consists of relatively small ornamental carvings, intended principally for use on furniture, but used to some extent for adding decorative touches where needed on door panels, wood trim, and other architectural surfaces. These are generally made from some wood composition.

Mr. Elliot blends the colors on a wall molding with a cloth to match a so-called "Tiffany" finished wall. The wreath below—a perfect imitation of delicate wood carving—is for use on furniture.

The other type consists of larger designs for wall and ceiling decoration. Some of these are cast from various compositions, but a newer form, made of pressed fiber or paper, is proving popular and has stimulated the present vogue for relief decoration because of its light weight, ease of application, and reasonable price.

Wood composition carvings and moldings come in a variety of designs covering the principal requirements of furniture decoration, including panel centers, key plates, knob plates, post aprons, and corner pieces. Wreaths, baskets, vases, urns, floral groups, garlands, and rosettes are among the patterns most generally offered. These are handled in much the same way as transfer and stencil decorations, except, of course, that their use is precluded on table tops and similar places.

The color treatment may be obtained in various ways. Where used on painted furniture the carvings may be finished in the trim color of the piece being decorated—colored free-hand with an artist's brush, wiped off in polychrome effects, dusted with bronze powder, or antiqued with brown pigment.

Applied carvings are still better adapted for use on stained (Continued on page 124)

This Model Flies Straight Up

How to Construct a Small Rubber-Driven Helicopter of New and Improved Design

By VINCENT JOHNSTONE

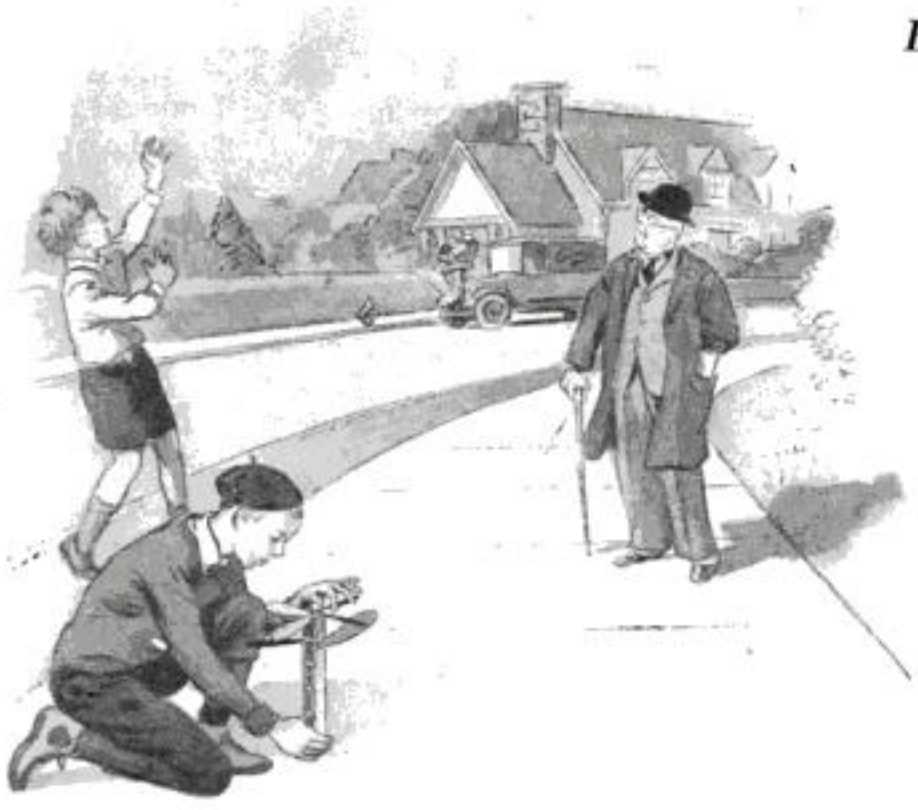


Fig. 1. Helicopter models, although novel and rarely seen, are easy to make and perform well in the air.

YOU may have to wait many years to see large airplanes that are able to take off and land from the same spot without any run whatsoever, but with relatively little difficulty you can build a spectacular flying model of a helicopter, as this type of ship is called.

Man-carrying helicopters, of course, have actually risen from the ground and flown in the same manner, but the main difficulty lies in steering them accurately in any desired horizontal direction. If you build and experiment with the surprising little model shown in Figs. 1, 2, and 3, you may discover some principle which, if adapted to a large helicopter, would make it more practical.

Before describing the construction of this recent model, I should like to remind you of the historic helicopter given to the Wright brothers by their father in 1878. This was made as shown in Fig. 4 and is known as the Penaud type.

After you have built the new half-minute helicopter, you can construct the earlier Penaud model, if you wish, by adding a little sail at the bottom of the model and eliminating the set of propellers fastened to the body, leaving only the one propeller mounted on the shaft. Indeed, you will have a better helicopter model than the Wright brothers had, as your Penaud model will be of the latest materials—balsa wood, ambroid type cement, selected rubber strands, and music wire.

The half-minute helicopter has made rapid progress in the way of records. At the time this article was written the official record stood at thirty-seven seconds. Unofficially, a flight of forty-one seconds has been made.

As the propeller mounted on the shaft rotates in one direction, a torque is produced in the opposite direction. On the Penaud model this torque was taken up mainly by the flat sail surface; but in our half-minute helicopter the problem is met by allowing the body to rotate with a set of left-hand propeller blades, which are attached to it. These opposed blades produce lift as well as counteract the torque, and the arrangement gives greater efficiency.

Helicopters are rather unstable. You will note this to be true with your model, especially if you build a two-blade propeller for the shaft (Fig. 2), for at the instant when the two sets of blades are parallel to each other the helicopter loses its stability; but, of course, it recovers as soon as the sets of blades separate. If you build a three- or a four-bladed propeller for mounting on the shaft, you will overcome most of the wobbling.

THE helicopter model's weight is most important. Be sure that you make your propeller blades extremely light; in fact, almost paper thin. Light weight is one of the main keys to the success of the machine.

The materials needed are 4 or 6 pcs. balsa ⅜ in. thick by 1¼ by 5¾ in. (triangular) for propeller blanks; 2 pcs. 1/32 by ⅜ by 8¾ in. balsa veneer; 8 pcs. 1/32 by 1/16 by ⅜ in. balsa veneer; 2 pcs. 1/16 by ⅜ in. square balsa veneer; 1 pc. No. 8 plated music wire for making S-hooks, bottom hook, and propeller shaft; and 3 small washers.

The body is made of two thin balsa veneer pieces, as illustrated, with cross-pieces of the same material at 1¾-in. intervals. You should see that the parts are well cemented together. The two ends are joined with pieces of balsa 1/16 in. thick, which are slightly rounded off.

A small brass washer should be cemented to the very center of the top piece on the outside to form the bearing. The bottom piece is provided with a hook cemented at the center. Incidentally, tweezers are handy for inserting the S-hook in place if the motor is wound with an egg-beater winder.

The propeller blades all can be made alike if you wish. They should be cut from triangular blocks of balsa ⅜ by 1¼ by 5¾ in. and carved in the usual manner, except that two (or three or four, as the case may be) are right-handed and two left-handed. The blades of the propeller operated by the shaft should rise at an angle of about 15° as shown. Use a 3/16-in. cube for the hub of a four-bladed propeller and a 3/16-in. triangular block for one with three blades. The shaft should be slipped in place loosely and the propeller balanced.

The blades which are fastened to the body also are attached at an angle of 15° to a horizontal line—one blade to one side of the body and (*Continued on page 117*)

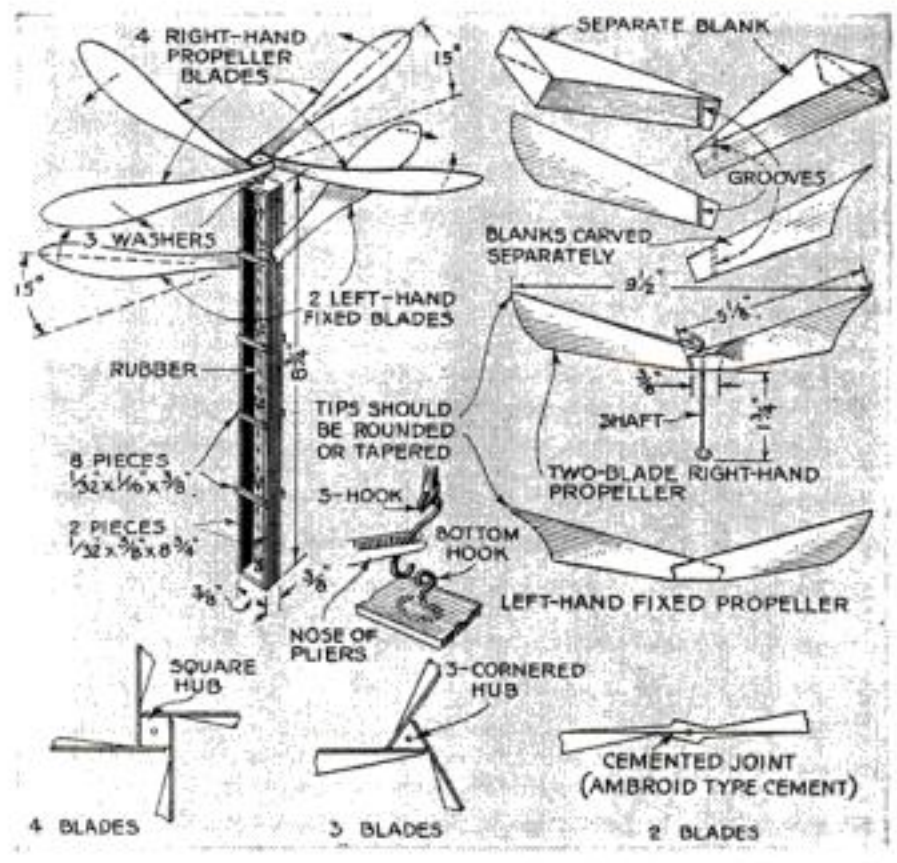


Fig. 2. A helicopter model of the type which holds the world's record. The upper propeller can have two, three, or four blades, as preferred.

Popular Science MONTHLY

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What Is Science?

SOME people still associate the word *science* with musty tomes full of involved mathematical formulas, read only by be-spectacled college professors. Actually, however, any book that deals with facts or principles is just as truly a work of science as is a textbook on chemistry or a volume devoted to the Einstein theory. The word *science*, as the dictionary defines it, means knowledge of principles or facts.

According to that all-embracing definition, anything outside the realm of pure imagination must necessarily be science.

Science is, therefore, the fountainhead of all human progress —of all human art—even of all human thought. For progress involves the use of knowledge and facts, art has to do with the skillful handling of materials which are the products of knowledge, and even the wildest flight of the imagination must, at least, have had a starting point in fact!

In this issue we are starting a new department which we may truthfully say is almost pure science. It is filled with new facts —curious facts—and above all with *interesting* facts. Turn to the POPULAR SCIENCE Scrap Book on page 57.

Making Stamps Stick

READERS of POPULAR SCIENCE MONTHLY, as a whole, display a keen interest in mechanical whys and wherefores. They want to know what makes the wheels go round. And when the wheels stop, they want to know why.

This analytical frame of mind is shown in a letter from one reader who found out why. Having noted, he writes, recent adverse comments in the newspapers regarding the poor sticking qualities of postage stamps, and having had some trouble of the sort himself, he studied the problem and came to the conclusion that the trouble is with the user and not with the gum on the stamps. They fail to stick, he explains, because they are not properly applied. The average person licks the stamp and thereby removes the gum, whereas if the envelope is moistened and the dry stamp pressed on it, the stamp will stick so tightly that it cannot be removed without tearing.

Whether a stamp sticks or not may seem to be a small matter, but who can tell when a loosened stamp may be the direct cause of a severe financial loss or, perhaps, result in upsetting the most carefully laid plans?

And the chap who will take the trouble to find out why his postage stamps don't stick is also the fellow who finds out why his car stopped and fixes it himself, instead of spending a good portion of his week's salary for a tow-in.

The Most Useless Thing

AMIDST whirling machines and flashing electrical apparatus at a recent science exposition in New York City, a few ounces of grayish-silver metal fashioned into rods and plates occupied a special glass case in one exhibit—unquestionably the most useless thing at the show. It was the newly-obtained metallic element "columbium," for which no use is known.

Although the metal, first found in a rare Massachusetts mineral, was discovered more than a century ago, last February there were only fourteen grams of it in the world—enough to make one disk a little larger than a half dollar!

But today, thanks to a new refining process devised by Dr. E. W. Balke, a chemist for a Chicago chemical and metal manufacturing concern, twenty-five pounds of columbium are in existence. The question is: Was he wasting his company's time and money to obtain a useless metal?

Useless? Science knows no such word. It thinks of helium, an unwanted gas until someone thought of filling airships with it; or argon, a "white elephant" until the introduction of gas-filled electric lamps; of neon, a worthless rarity once, that today flashes a scarlet message from thousands of advertising electric signs throughout the land.

Columbium useless? Chemists will find a use for it. Tomorrow it will join the ranks of the myriad products that make life better for you and for me.

It Won't Be Long Now

"MOIRÉ silk cushions and upholstery in cheerful colors mounted with the owner's initials are charmingly appropriate in this unique plane interior."

This caption appeared recently beneath a photograph of a luxurious plane cabin in a New York newspaper. And on the woman's page, surrounded by the latest skirt-length hints from Paris, recipes for brand-new salads and desserts, and advice on summer care for the baby!

The innovation is significant. When automobile manufacturers began to concentrate on upholstery, flower vases, and other trinkets and accessories for their car interiors, the day of universal motoring was upon us. Women, as everyone knows, are the buyers of the nation; at any rate, they are the power behind the buyers' thrones. The fact that airplane manufacturers are beginning to consider their tastes and preferences is a sure sign that the day of the family plane is nearer than most of us suppose.

They Are Saying—

"RADIO is going to produce a superuniversity in the United States that will be the greatest educational and cultural institution in all history."—Major General George O. Squier, retired.

"Science, you know, is a lot of fun."—Dr. A. A. Michelson.

"We are not ready for night flying with passengers until we have four-motored planes."—Col. Charles A. Lindbergh.

"Man, rather than vermin, is now the chief carrier of disease."—Dr. Shirley W. Wynne, Health Commissioner, New York City.

"I believe in Spinoza's God, who reveals himself in the orderly harmony in being, not in God who deals with the facts and actions of men."—Professor Albert Einstein.

"Sleeping is something to be learned, just like swimming or dancing."—Dr. Edmund Jacobson, University of Chicago psychologist.

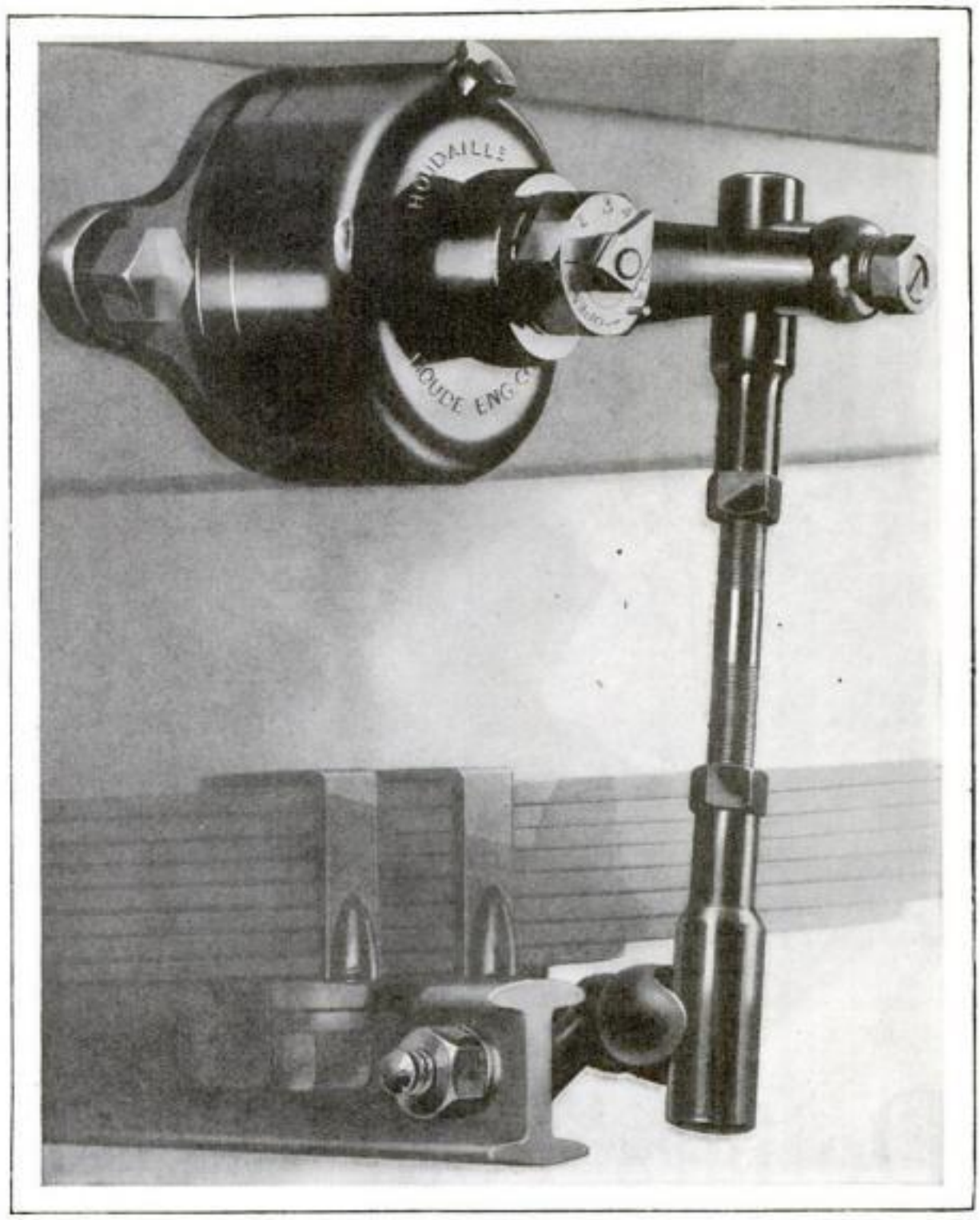
"Every sane man knows that commercial air transport has a real future."—Elisha Lee, Vice President, Pennsylvania Railroad.

"If the earth should move far from the sun, rain would cease and conditions might be so changed as to make life impossible." —Dr. William Bowie, U. S. Coast and Geodetic Survey.

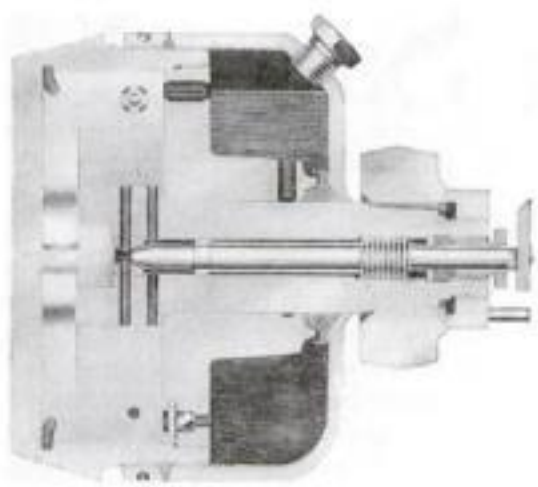
"At the present time heredity is not considered of importance as a cause of cancer."—Dr. Shields Warren, Palmer Memorial Hospital.

"It would seem that Nature made every possible mistake before she reached her greatest achievement—man. Or perhaps some would say her worst mistake of all."—Dr. Arthur Eddington, Cambridge University astronomer.

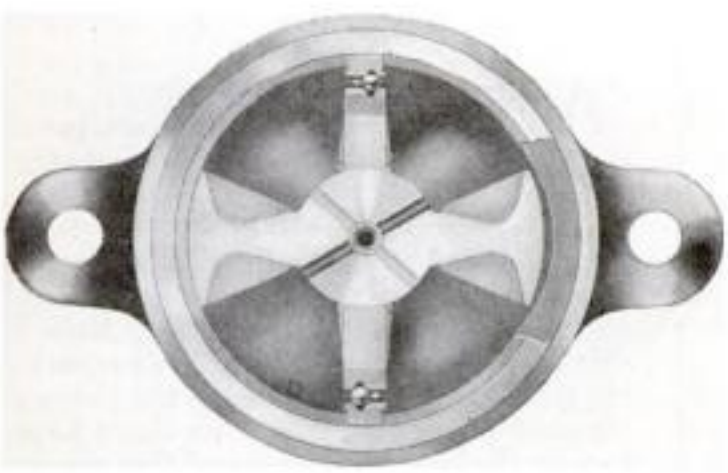
"The time has passed when men are lured by the hope of finding great tracts of land in the region of the North Pole."— Peter Freuchen, Danish explorer.



Insist that your car be HOUDAILLE equipped



These X-ray views show the automatic replenishing valve, air vents and the reservoir which holds a reserve supply of fluid and eliminates the need of packing the instrument against high working pressures. The one moving part of the Houdaille instrument is the double or balanced piston. With pressure chambers on both sides of the shaft, side thrust is neutralized and wear is reduced to the absolute minimum.



The Houdaille Hydraulic double acting shock absorber is frequently imitated in appearance. To avoid disappointment, identify the genuine Houdaille by the name stamped on each instrument—HOUDAILLE, *Manufactured by* HOUDE ENG. CORP.

because . . Houdailles are not in the experimental stage. They are the result of 27 years of experience in building the hydraulic shock absorber which is now *the world's standard of comparison.*

because . . Houdailles are easy to adjust.

because . . Houdaille's double or balanced piston assures supreme riding comfort for years.

because . . Houdaille's patented reservoir automatically replenishes the fluid in the working chambers.

because . . Houdaille's patented air vent allows the escape of gas and air from the working chambers. Fluid mixed with air or gas changes viscosity and in a hydraulic shock absorber causes loss of resistance.

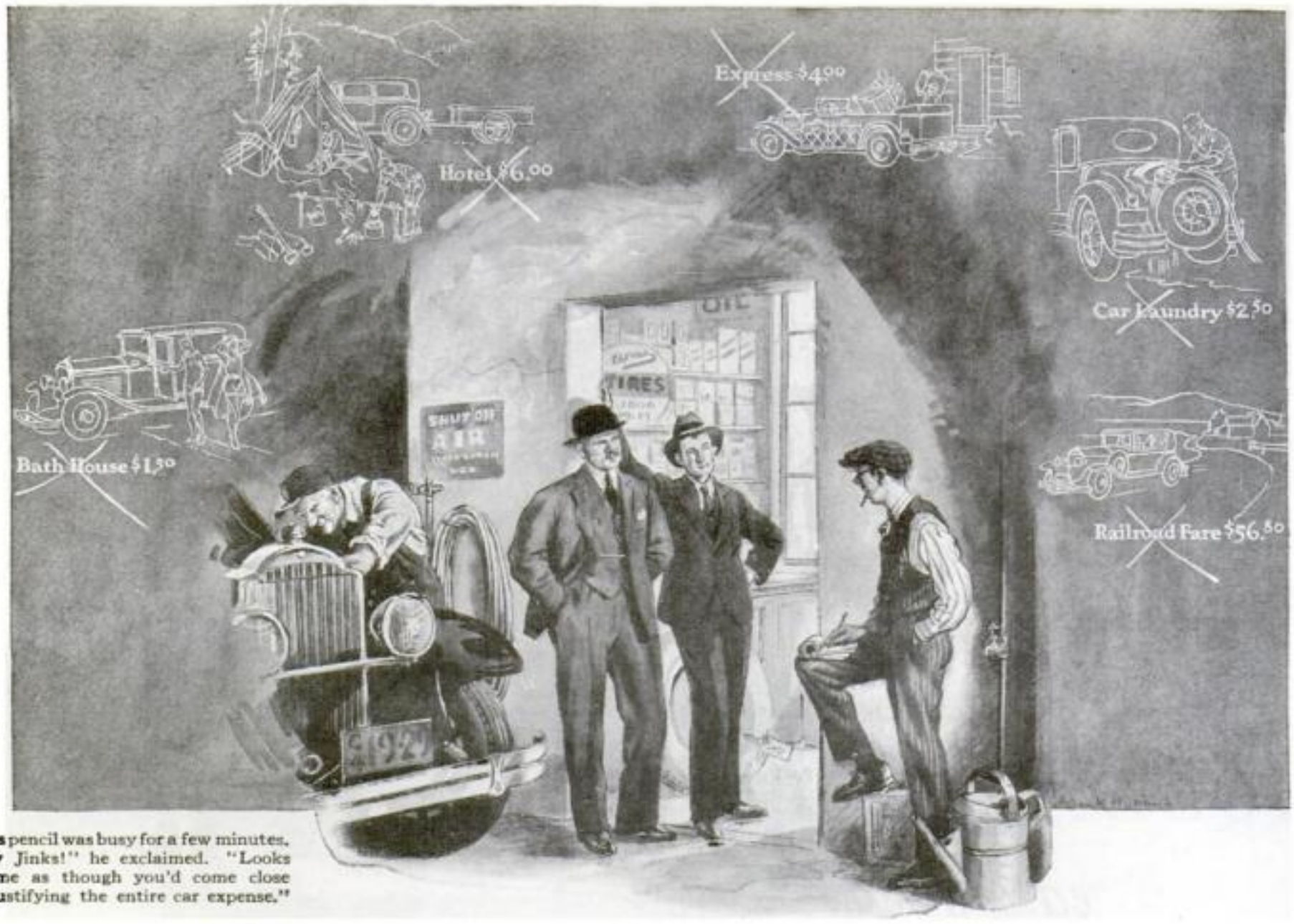
because . . Houdailles have been selected *on merit* by the engineers who build Lincoln, Pierce-Arrow, Cunningham, Stearns-Knight, Jordan, Ford, Nash Advanced Six, Chrysler Imperial, Studebaker President, Graham-Paige and many European cars.

Your car dealer can supply Houdailles

HOUDE ENGINEERING CORPORATION, BUFFALO, N. Y.

HOUDAILLE

Hydraulic Double-Acting SHOCK ABSORBERS



Joe's pencil was busy for a few minutes. **"By** Jinks!" he exclaimed. "Looks **to me** as though you'd come close **to justifying** the entire car expense."

Dollars Your Car Can Save You

By
MARTIN BUNN

AN ARGUMENT between two customers that threatened to develop into a regular fight was in progress just outside the Model Garage. Gus Wilson stood it about as long as he could.

"Hey! You guys outside there!" he shouted, banging on the side of a convenient pail with a monkey wrench to emphasize his remarks. "Isn't it hot enough around here without you two spilling all that extra hot air? Joe, see if you can't shoo 'em away."

Joe Clark, Gus's partner in operating the Model Garage, and the bookkeeping member of the firm, went to the rescue.

"What's it all about?" he interrupted as, pencil in hand, he confronted the two argumentative gentlemen.

"Ted, here, is shooting off a lot of bunk about how his car doesn't cost him anything to run," said one of them.

"But it isn't bunk, Mac," protested the other. "I know what I'm talking about. Don't I pay the bills?"

"Just arguing won't get you anywhere," said Joe. "Why not do a little figuring and see how it comes out in black and white on paper? If I understand you right Ted, here, is convinced that his car doesn't cost him anything to run, while you, Mac, claim that's a lot of applesauce and that your car is running you straight to the poorhouse. Is that the sense of it?"

"You've got it." Ted agreed.

"But, Joe," Mac protested, "Ted can't possibly be right. You can't spend money and have it, too, you know. That's ——"

"Just a minute, Mac," Joe broke in. "Let's settle this thing on paper—not with chin music. You've both got the same kind of car and you got 'em about the same time, so we ought to get some pretty interesting figures out of this. Let's get Mac's story on paper first. How do you figure your car's making your pocketbook so limp?"

"It's as plain as the nose on my face," Mac asserted, subconsciously scratching that rather prominent feature. "I drive about six thousand miles a year, and you've told me before that it costs at least eight cents a mile to operate a car like mine. That makes four hundred and eighty dollars right there."

"ALL right, I've got that down," said Joe as he noted the figure on a piece of paper. "Anything else you can charge against the car?"

"Lots," grumbled Mac. "Every time we go out for a ride on Sunday we invite some people to go with us, and I get stuck for dinner for the crowd. Every time I drive to a show in the city there's a parking charge added to the cost of the tickets. Because we've got the car we don't have to take the last train home and that means we go to some restaurant instead of raiding the ice box after we get home.

"Then we wouldn't belong to the country club if we didn't have a car to go back and forth. (Continued on page 129)

Ask Gus—He Knows

KEEPING your foot on the clutch pedal all the time is bad business. It puts extra wear on the clutch throw-out bearing, and every time you go over a bump, your foot pushes the pedal down a bit and the clutch slips. The friction surfaces have enough to do starting the car in the regular manner without giving 'em extra wear that way. They'll last a lot longer if you don't "ride" the clutch.

Don't have your motor roaring when you let in the clutch to start the car. The slower the motor is turning over and the more carefully you let in the clutch, the less the wear on clutch facings.

Remember that the clutch is the link between the motor and rear wheels. It has to stand the gaff every time you try to jump from nothing to full speed in no time at all.

Photograph by Bachrach

MAJOR JAMES E. HAHN

President AMRAD CORPORATION, of BOSTON
President DE FOREST CROSLEY, LTD., of TORONTO
Director CROSLEY RADIO CORP., of CINCINNATI
Says:

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J Hayathon

Look for this mark on every Radiotron

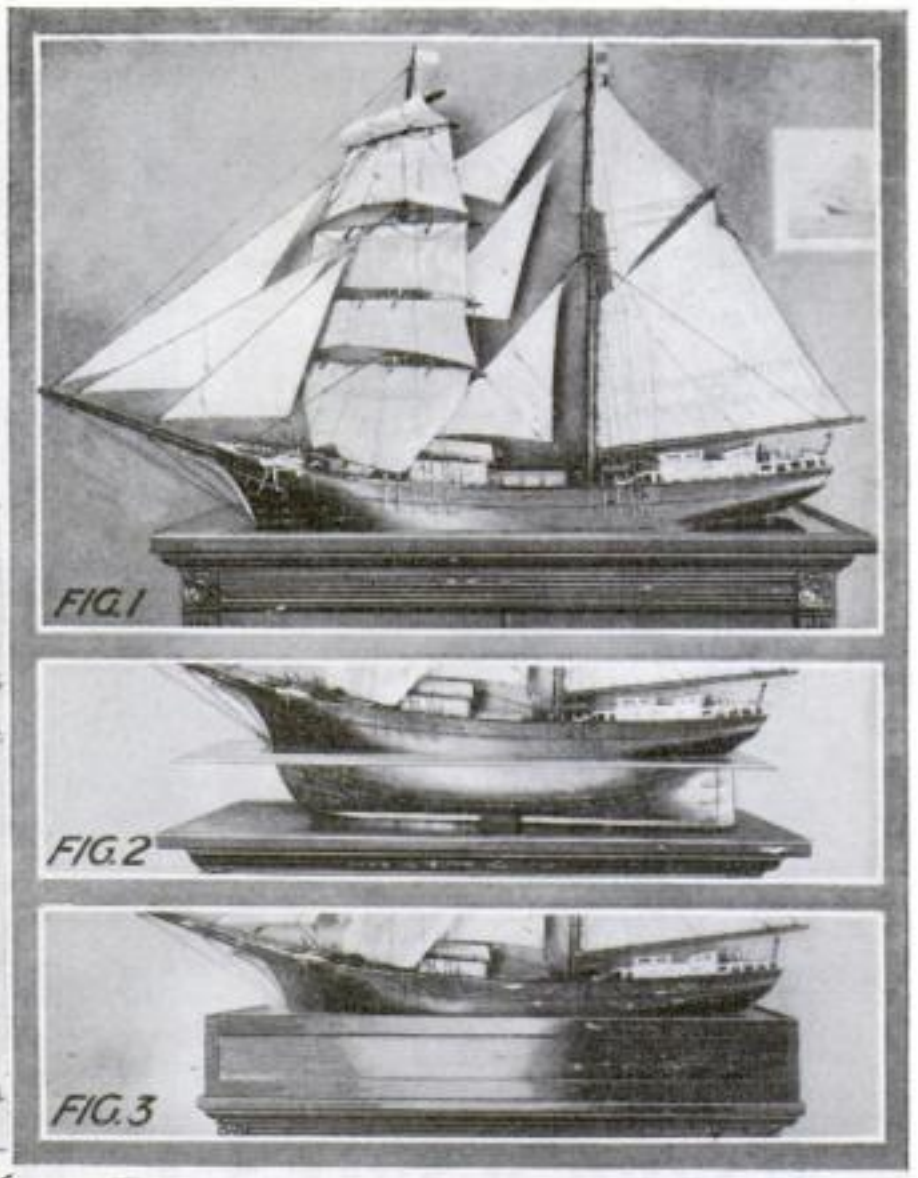
The widespread endorsement of RCA Radiotrons by makers of quality radio sets is your assurance that they will give you finer reception. Ordinarily they should serve you faithfully for a year of average use. After that a brand new Radiotron should be placed in every socket. This complete reequipment is wise because worn tubes are a drain on new ones.

RCA RADIOTRON

RADIOTRON DIVISION
RADIO-VICTOR CORPORATION OF AMERICA NEW YORK CHICAGO ATLANTA DALLAS SAN FRANCISCO

Novel Mount *for a* Ship Model

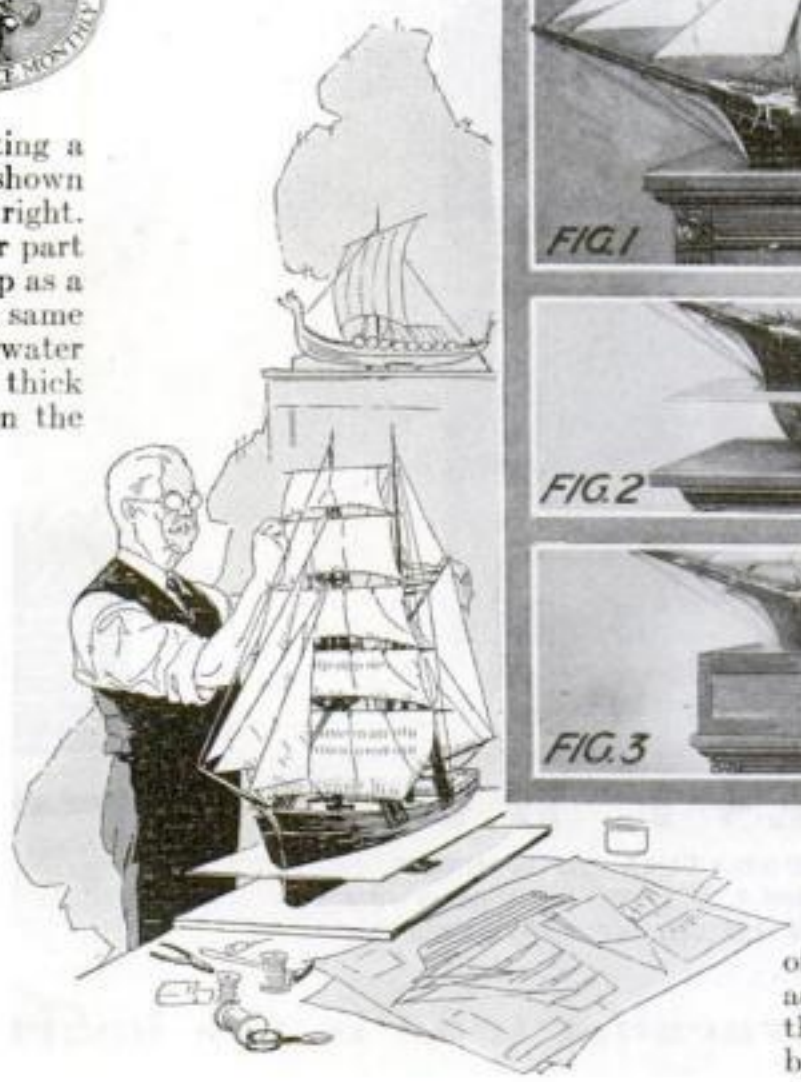
The Hull Appears to Be Afloat Yet the Underwater Part Can Be Examined—Short Cuts in Rigging

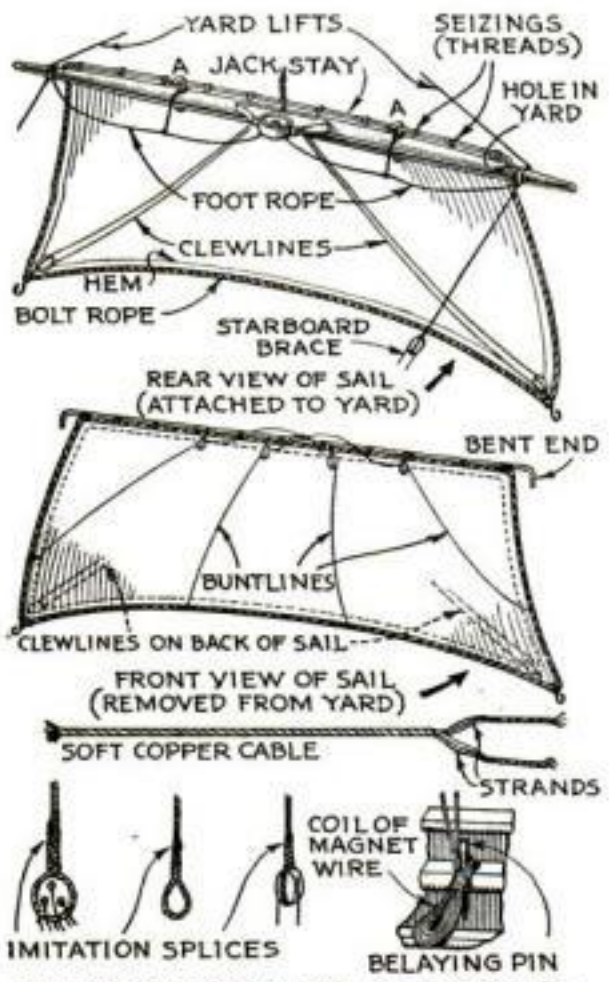


This little brigantine, a masterpiece of perfection in all details, can be displayed either as a water-line model with sails or a full-hull model without sails.

A PRACTICAL way of mounting a divided-hull ship model is shown in the illustrations at the right. Figure 1 shows the upper part of the ship resting on a bookcase top as a water-line model. In Fig. 2 is the same model with the bottom, or underwater portion, attached, and with a 1/16 in. thick aluminum plate interposed between the two hull sections. This plate may be removed if the model is to remain as a full-hull model. An aluminum sheet when slightly tarnished has the effect of still water, as in a calm sea.

The two-part hull and the interposed aluminum sheet also appear in Fig. 3, but with three panels of wood which match the wood and finish of the bookcase and which, when in position, conceal the front and ends of the underwater part of the hull. This gives a model the true effect of a ship sailing, which is not the case when a model has the sails spread and at the same time reveals the full hull. A view of the entire hull in this case is quickly disclosed by removing the three panels. This is easily done, as they are not permanently fixed in place.





Method of attaching sails so they can be readily removed; suggestions for wire rigging.

A shipshape way of getting sail on a model and also some suggestions on the use of wire standing rigging in place of cord are illustrated at the left.

To begin with, the yards on all ships (including the clipper ships, except the very old ones) were provided on the upper side with stout iron rods called "jackstays," to which the sails were attached by seizings of marline or rope yarn. In this model a straight wire with bent ends is made, and the sail attached to it by seizings of thread spaced as shown.

The wire jackstay with the sail attached is removably fastened to the yard by pushing the bent-down ends into holes provided at the ends of the yard; a further fastening is provided by the swivel hooks *AA*, which are formed from small brass nails. The blocks for buntlines are seized to the jackstay.

The fastenings of braces, lifts, and footropes to the yard is made clear in the illustration. These rigging parts, as well as all shrouds, backstays, and headstays, may be easily made (and set up) from strands of small, soft copper cable, or cable laid up from fine copper wire. This cable is easily untwisted, and part of the strands, when retwisted into smaller cable, may be brought to the correct proportion of the various rigging details. Another advantage of wire standing rigging is that an imitation splice is easily made by twisting the end back on itself.

Another use of wire—small cotton covered magnet wire, dyed brown—is the making of neat hand coils to be hung on the belaying pins.

The bolt ropes on the sails and all running rigging should be dyed brown. A good effect of weather-beaten canvas may be produced by dyeing the sails faintly with a small pinch of black textile dye dissolved in water.

Tops, Crosstrees, and Blocks

IN BUILDING two models of the *Sovereign of the Seas* from POPULAR SCIENCE MONTHLY Blueprints Nos. 51, 52, and 53, I made use of several ideas that other readers may find useful.

For the tops, crosstrees, and caps, I broke up some strawberry boxes and glued two pieces together so that the grain of one ran at right angles to the grain of the other. After the glue had hardened, I cut the shapes out with a coping saw and rubbed them down to the proper thickness on a piece of sandpaper.

The blocks were made from the hard, close-grained wood of a ten-cent zigzag folding rule. After drilling the wood, I whittled each block with a sharp knife, leaving it on the piece as long as possible. Some of the blocks were little larger than an ordinary pinhead.—T. C. MORRIS.

Helpful Ideas *for the* Car Owner

A Handy Floor Board Tool Box—Fitting the Piston Rings—Ingenious Indicators—Locking the Gas Tank

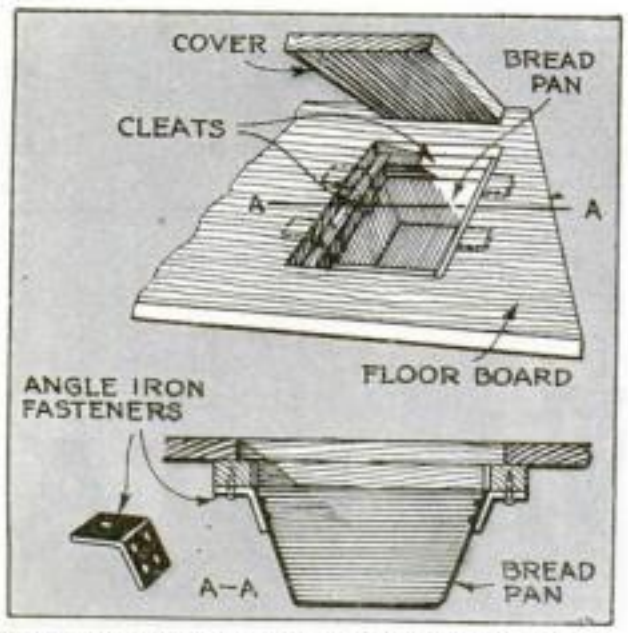


Fig. 1. How to construct an ingenious and simple floor board tool box from an ordinary bread pan.

A NEAT and simple floor board tool box made from a bread pan is shown in Fig. 1. To install, cut out a piece of the floor board with a keyhole saw. Underneath the opening nail two strips to form a support for the piece you have sawed out, which will be the cover of the box. To this strip fasten four angle iron pieces set as shown in the drawing.

If you use another kind of pan—for instance, one with straight sides—it will be necessary to rivet or bolt the sides of the pan to the angle iron pieces. The tool box can be located at any point where the play of the springs will not cause any part of the running gear to hit it. An advantage of this type of tool box is that it is concealed by the floor mat and consequently there is little chance of the tools being stolen.

Stop Light Indicator

THE common method of hooking the dash light in series with the tail-light, using three-volt bulbs at each point, works nicely with the tail-light, but the system does not work with the stop light, which uses a much more powerful bulb, for no one wants a large bulb shining from the dash. The wiring arrangement shown in Fig. 2 eliminates this difficulty. A one-and-a-half-volt flashlight bulb is connected across the wire that leads to the stop light from the stop light switch. When current flows through a wire, there is a loss in voltage which can be read by means of a voltmeter connected at both ends of the wire. The flashlight bulb requires very little voltage to make it glow, and the drop in voltage in the wire leading to the stop light is sufficient to operate it. The beauty of the system is that if the stop light bulb burns out the flashlight cannot light, but if the flashlight burns out it will not affect the operation of the stop light. If the flashlight does not glow brightly enough add a few feet to the wire marked X in the diagram.

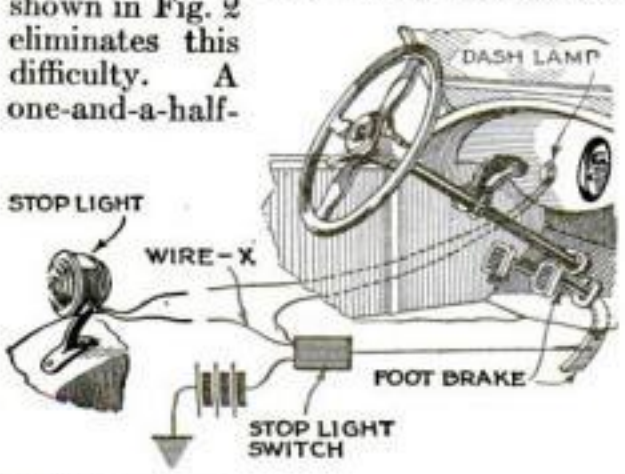


Fig. 2. The prize winner—the arrangement of a novel flashlight indicator that tells condition of stop light.

Ten Dollars for an Idea

James Pesek, of Chicago, Ill., wins this month's $10 prize for his suggestion for a stop light indicator, shown in Fig. 2, in lower left-hand corner of page. Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at usual rates.

Fig. 3. A tin can with top and bottom removed aids in sliding new piston rings into piston grooves.

Installing Piston Rings

ONE of the simplest ways to fit piston rings to the grooves of a piston is to take a tin can slightly smaller than the diameter of the piston and cut away the bottom and the top and slit it on one side. Slide the rings on to the can, as shown in Fig. 3. Push the can down over the top of the piston until the edge of it is at the edge of the lowest ring groove. Slide one of the rings down into the groove. Pull the can back to next groove, and so on.

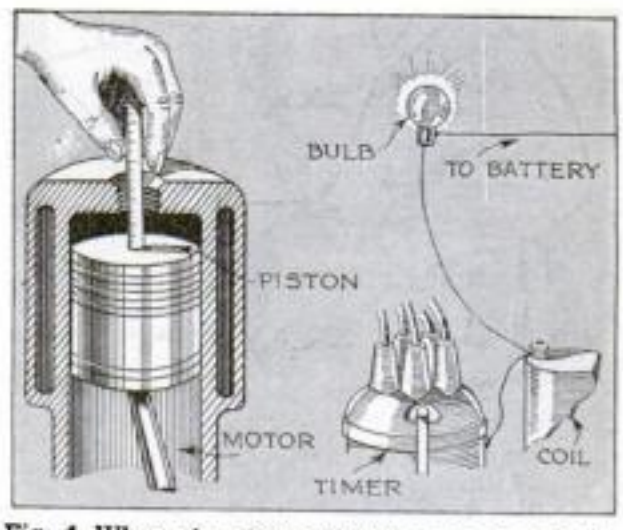


Fig. 4. When the timer contacts are closed, the bulb lights; when they break, the light goes out.

Spark Time Indicator

IT IS difficult to locate the exact point at which the contacts in the timer break and thereby cause the spark in the cylinder. You can, however, wire an electric light bulb, as shown in Fig. 4, to get an absolute indication of the exact moment when the contact breaks. One terminal of the bulb is wired directly to the battery and the other to the terminal of the coil that is connected to the timer. When the contacts are closed the bulb will light. When the contacts break, the bulb will go out.

This method of timing or checking the ignition system is one which will be found helpful not only to the garage mechanic but to the motorist who works on his own car in his spare time. It does away with guesswork, and because of its simplicity of operation saves considerable time on the job.

Locking Your Gasoline

GASOLINE thieves will be foiled by the fuel tank cap lock shown in Fig. 5. This is an ordinary small cabinet door lock which should be riveted, or screwed and riveted, to the under side of the tank cap. Make sure that the lock does not project far enough to interfere with placing the cap on the tank. Mark where the bolt of the lock comes when the cap is tight down and cut a slot in the inside of the opening into which it may drop when the key is turned.

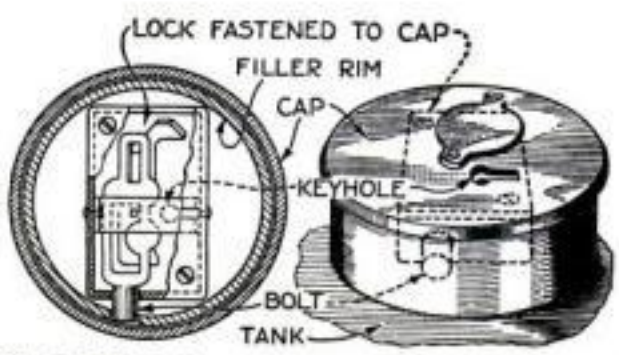


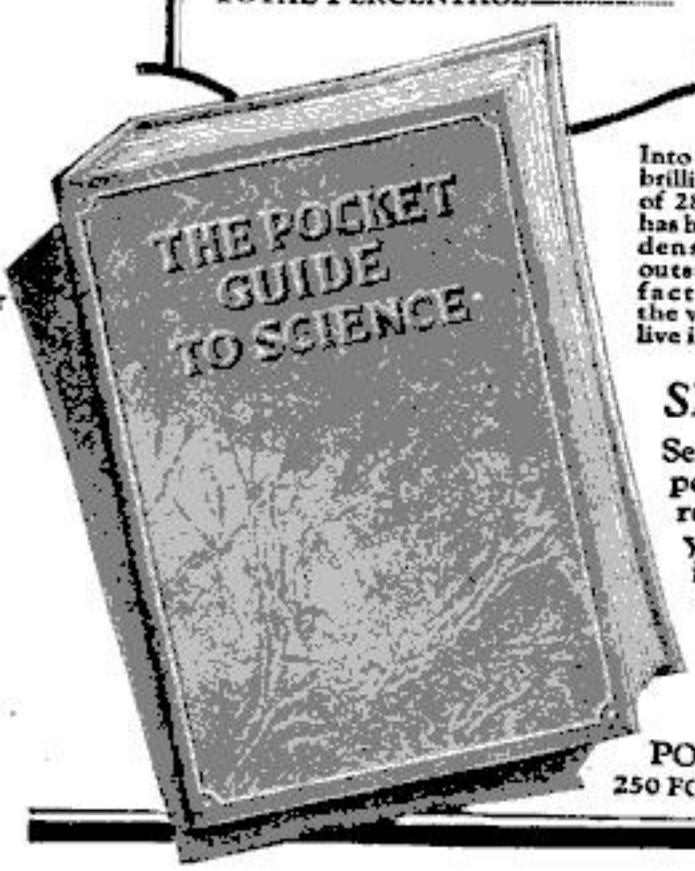
Fig. 5. This fuel tank cap lock is an ordinary small door lock riveted or screwed in place under cap.

Try this Yardstick on YOUR Brain

MEASURE YOUR KNOWLEDGE *with the* POPULAR SCIENCE QUESTIONNAIRE

1. Why does radium continue to give out heat for thousands of years?
2. Are the stars solid like the earth?
3. How was the earth formed?
4. Why is glass transparent?
5. How do we know that the earth is slowly shrinking?
6. What is an electric current?
7. How was petroleum formed?
8. Do electrons really move through wire when an electric current is flowing through it?
9. What physical changes in your body are produced by fear?
10. How do muscles exert power?
11. What are X-rays?
12. Can we see atoms with a microscope?
13. Why does heat expand things and cold contract them?
14. Why does the moon appear to change its shape from time to time?
15. What is the brain made of?
16. Why is it possible that the inside of the earth is growing hotter instead of colder?
17. Why is frost more likely on a clear night than on a cloudy one?
18. Does thinking use up the thinker's energy?
19. Which travels faster, electricity or light?
20. What simple test will distinguish wool from cotton?
21. What makes the noise of thunder?
22. Why would men ultimately suffocate if all the green plants were killed?
23. Does the boiling of water remove the impurities in it?
24. How do the living cells of the body get the energy with which to do their work?
25. How is the speed of light measured?

TOTAL PERCENTAGE



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May we ask you to make this test carefully, reading the questions slowly and giving thought to each one? When you cannot answer one satisfactorily to yourself, put a zero (0) beside it.

On the other hand, give yourself credit of four (4) for each satisfactory answer. Then when you are through, see how near you have come to making a mark of 100.

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When Front Doors *Need* Paint

As They Do Frequently, You Can Refinish Them Yourself so They Will Not Blister or Crack by Following the Hints of F. N. VANDERWALKER

OUTSIDE doors and floors are subjected to the hardest service and consequently require more attention than other surfaces of a house to keep them from looking shabby. The refinishing of doors once or twice between paintings of the outside or the inside of the house saves the housekeeper considerable anxiety about appearances. After all, guests gain their first impression from the general aspect of the entrance.

Refinishing doors is one of the tasks any handy man can do well, thereby saving money and avoiding the inconvenience of having to hunt up a professional painter who may not be especially enthusiastic about doing small jobs of this kind.

In a previous issue (August, 1928) of this magazine, methods for applying an enamel finish to outside doors were described. It should be of interest also to know how to apply a high-grade paint finish, which costs less and is easier to apply.

As a rule the old and soiled painted surface is in good condition as far as soundness of foundation is concerned, but often the paint is chalking off. Such a surface needs to be sandpapered just enough to clean and smooth it.

When a stained and varnished door is to be painted instead of revarnished, it should be sandpapered well to cut off any gloss or crumbling varnish. It is not necessary to remove old varnish that has merely become dull in places, but it should be sanded enough to make it uniformly dull. The same is true of old enameled surfaces.

Doors which were merely oiled, or stained and oiled, require sandpapering. If they have been allowed to weather until the wood has checked and opened up and raised in ridges, considerably more work is called for; they should be sanded with No. 1 paper wrapped around a block of wood until the ridges and rough places have been made smooth, and finished with No. ½ or No. 0 paper. The sanding of painted, varnished, and enameled surfaces that are in sound condition may be done with No. ½ paper.

Beautiful entrances such as this lose much of their charm if they are not kept clean and freshly painted. They must be repainted more frequently than the remainder of the house.

Any first-class house paint is suitable for doors. At least two coats should be applied, and three coats are well worth the slight additional cost.

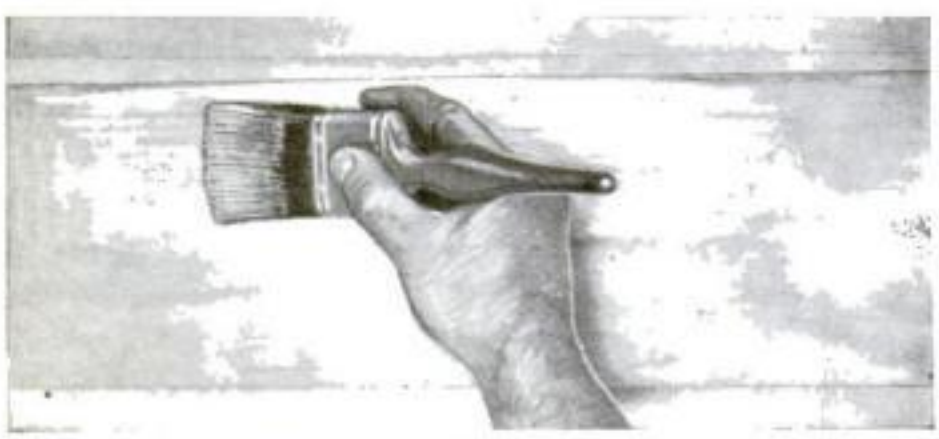
In painting doors that are exposed to the direct rays of the sun and therefore might blister badly if the undercoats were too rich in oil, the point to be careful about is to use the least possible amount of oil in the first and second coats. If you use undercoats that are rich in oil, they are too elastic—more elastic in time than the finishing coat of the same paint because the weather reduces the elasticity of the finishing coat before it affects the undercoats. When the surface gets hot, the undercoats expand more than the finishing coat and the surface may be marred by blistering or "alligatoring."

If you use ready-mixed house paint, you can reduce its elasticity for the undercoats by this method: Pour off into a separate can the oil that has risen to the top and take out one half or one third of the pigment, depending upon whether you are to apply two or three coats. Mix the pigment for the undercoats with turpentine only, but for the last coat mix the pigment with oil alone — that is, the oil drawn off when the can was opened.

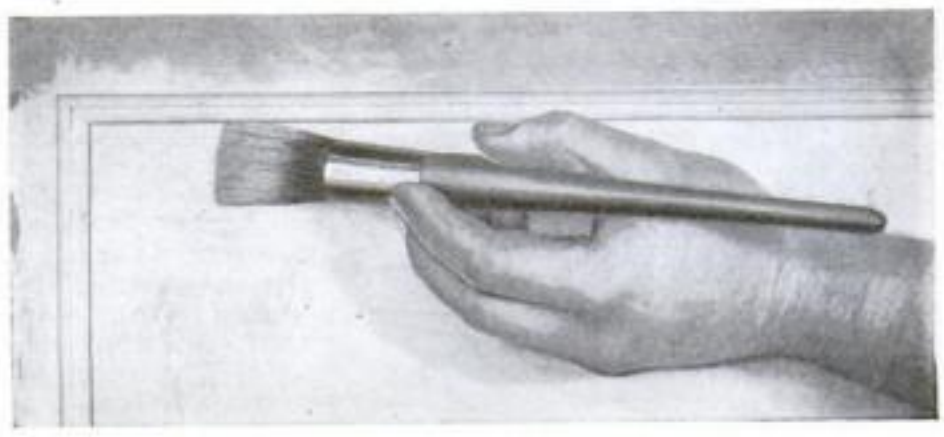
If you are to use white lead paint, mix the lead for the undercoats with turpentine only and mix the last coat with about one fourth turpentine and three fourths boiled linseed oil.

In case you want a light tint rather than white, add to the lead the desired tinting color ground in oil; this comes in 1-lb. cans. For very dark colors such as dark green, use ready-mixed paint of the color wanted for all coats, or use white lead undercoats tinted about half as dark as the finishing coat is to be, and then use for the last coat a tinting color, such as medium, light, or dark chrome green, thinned with about one fourth turpentine and three fourths boiled linseed oil.

When a door with varnish upon it—or any other varnished surface—is to be painted, and assuming that the body varnish is still firm, the first coat of paint should be mixed (*Continued on page 118*)



For applying the paint you need first of all a good quality brush 2 or 2½ in. wide with long bristles for edges, panels, and flat surfaces.



To cut neatly around lights of glass and for other delicate work, you should have a round or flat brush 1 in. wide, known as a sash tool.

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AN EXPANDED gas orifice makes a blow-torch a piece of junk. And it's the easiest thing in the world to enlarge the orifice in an ordinary torch. But a No. 32 Clayton & Lambert blow-torch has an orifice that *can't be enlarged* — no matter how carelessly or how tight you close the valve. It's a patented Clayton & Lambert improvement—one reason why you get longer service when you buy a Clayton & Lambert.

In addition to being non-spreading, the orifice will not clog. As you close down the valve the carbon cleans out automatically. The improved orifice is but one of *many* Clayton & Lambert advancements. Every bit of mechanism is designed to give you quicker, better action. Inside and out, a Clayton & Lambert is built for long, strenuous use. Where a hard bump might occur, a Clayton & Lambert is reinforced. Wherever extra protection should be—you'll find it in Clayton & Lambert.

As an example, all Clayton & Lamberts are made *non-explosive* by a patented method of building the fittings into the tank. The vaporizing chamber is another Clayton & Lambert feature. Its special vein system gives you quicker heat—more heat—and cuts down your fuel bills. You can't see these things which Clayton & Lambert have done to give you the blow-torch you want. They're inside—in the "works," the important part of a torch. But they're there—along with numerous other refinements. They account for superior performance and durability. And that's why Clayton & Lamberts are the most popular torches in the world.

You'll know a Clayton & Lambert by the red handle with a gold stripe.

C & L 158

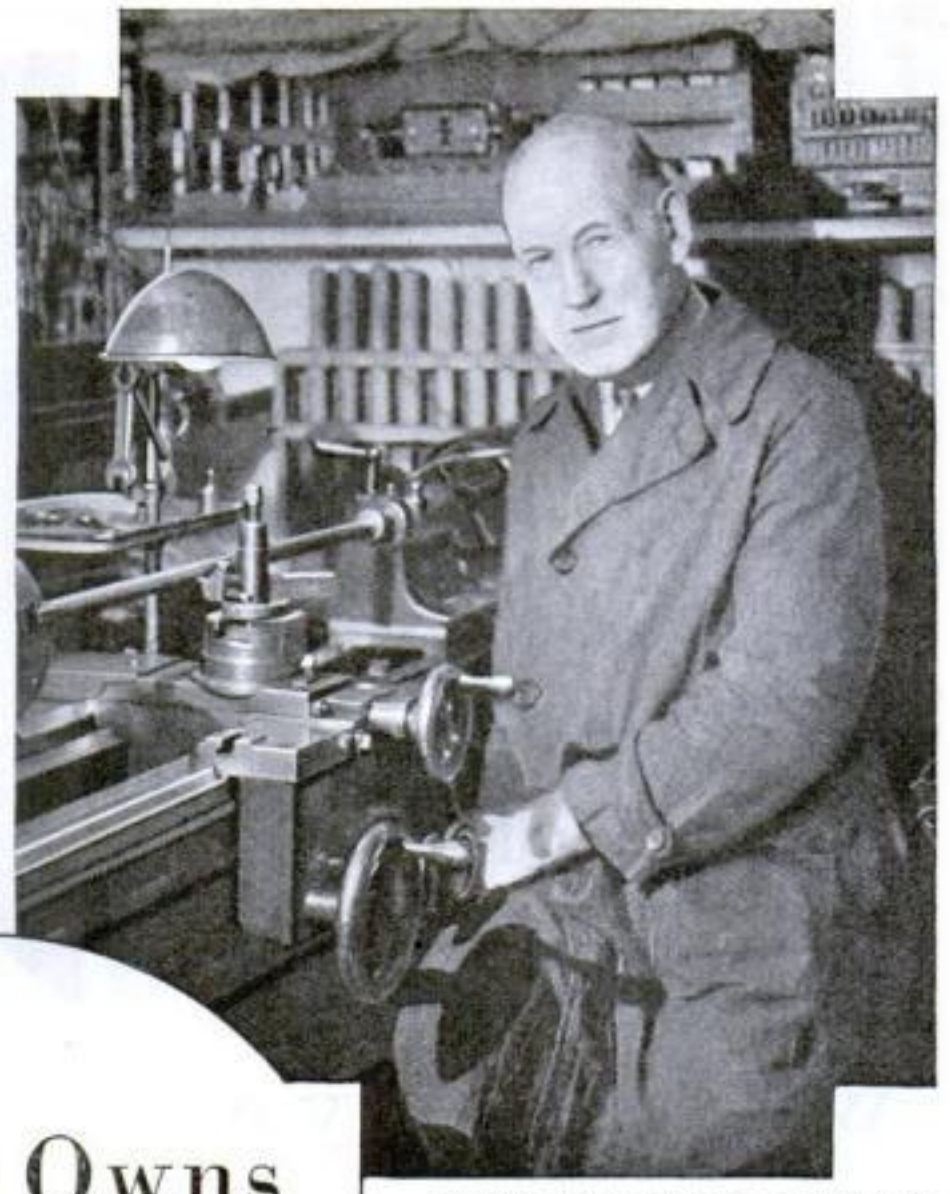
This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the gold-banded, red handle.

CLAYTON & LAMBERT

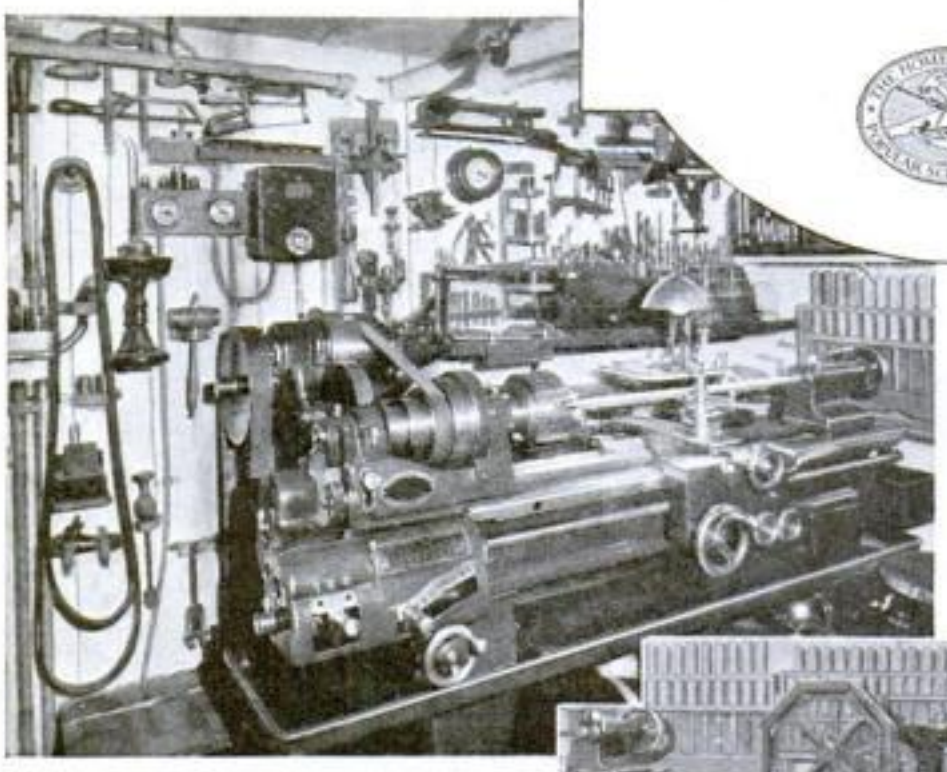
MANUFACTURING CO., Detroit, Mich.

The metal working bench is located in a corner at the left of the engine lathe. Screws, bolts, nails, and small hardware are kept in glass jars. Above the bench are racks for hammers, wrenches, and many other tools, including a large number of auger bits, which are hidden by the shelves. Planes are stored beneath.

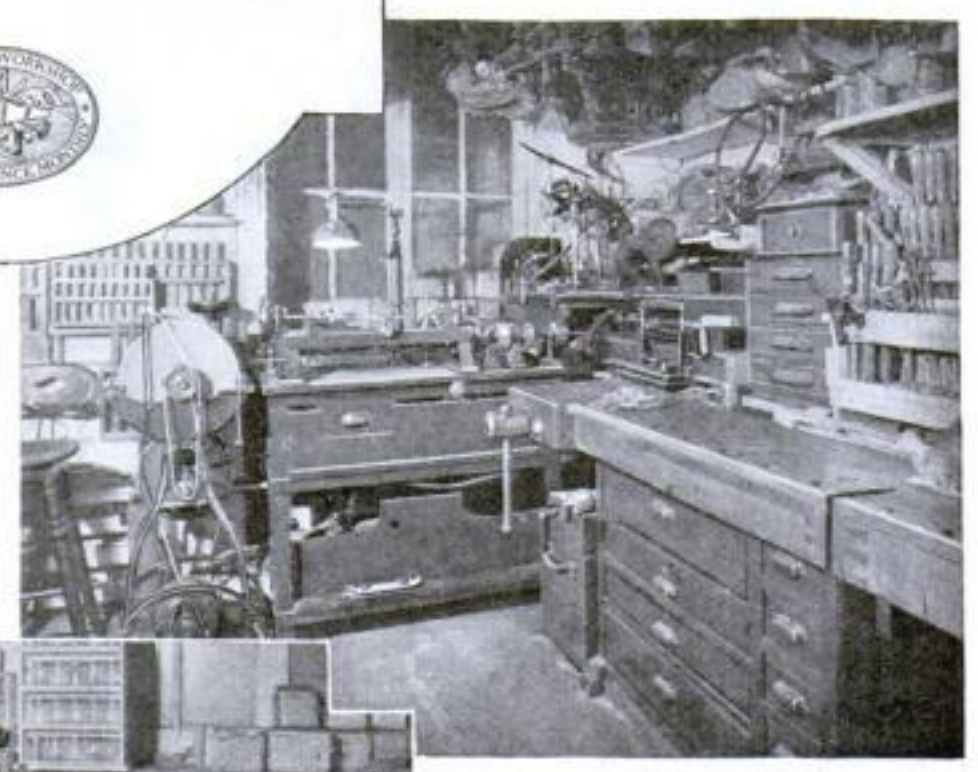
Doctor Owns *Marvelous* Little Shop



Richard J. Scofield, M.D., of New York, in his extraordinarily complete home workshop. He estimates that he has fully one thousand tools. He finds relaxation from his exacting professional duties by working at his engine lathe and doing a variety of cabinetmaking, metal spinning, and decorative and hammered metal work.



The thoroughly modern engine lathe has a swing of 12 in. and a bed 5 ft. long. Dr. Scofield has a complete and costly collection of tools and attachments for use with it.



The cabinetmaker's bench is shown at the right above. The drawers are filled with tools. On the other bench is a small lathe of 4-in. swing and with a 2 ft. 6 in. long bed. A grinding head with carborundum wheels is mounted on the same table. Heavier grinding is done on the grindstone. Each machine has its own motor.

A small band saw, a circular saw, and a jointer are shown at the left. All Dr. Scofield's small machines, including the speed lathe in the view above, are mounted in such a way that they can be rolled into a convenient position for use. His shop is too small to allow each machine to have its own fixed position.

HOW does your workshop compare with Dr. Scofield's? Even if far less complete, it may be noteworthy for its arrangement, neatness, convenience, or some special feature. Send a photograph or photographs of it, accompanied by a brief description, to the Home Workshop Editor. For each photograph that is found suitable for publication, five dollars will be paid.

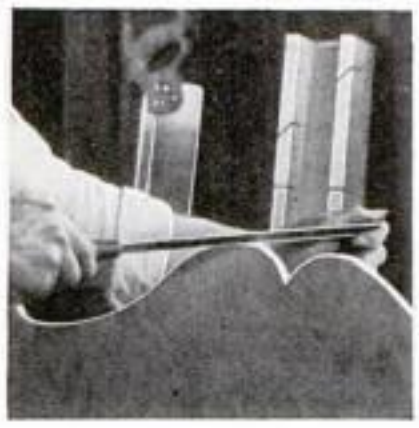
How to Use Your Back Saw

Told by the Makers of "The Saw Most Carpenters Use"

IT is Disston Steel and Disston Skill that make Disston Saws supreme. Steel made in the Disston Steel Works puts stamina, toughness, long cutting life, into every Disston Saw, Tool, and File.

Disston Skill gives better balance to every Disston Back Saw; makes Disston Hand Saws lead the world; and maintains Disston leadership in compass saws, dovetail saws, coping saws, and other small saws for every purpose. No other saws can give you such lasting satisfaction.

Ask for Disston! Hand Saws, of course; and every other type of saws for bench or machine work.



Files for the Wood Worker

Disston Cabinet Files (fine teeth) for smoothing and finishing wood surfaces, easing tight doors and drawers, etc. Disston Wood Rasps (coarse teeth) for rough and fast cutting, enlarging holes, etc. Half-round 8" Cabinet File, 65c. Flat 8" Wood Rasp, 50c.

Handiest of Pocket Levels

For truing up construction work, levelling shelves, etc., use a Disston Featherweight Pocket Level. It is the lightest and handiest level made. Length, 9"; weight, 2 oz. Aeroplane aluminum. Three proved glasses. $1.25.

For Cutting Dovetails, etc.

Wherever the finest possible joint is needed, and for dovetailing, pattern making, etc., use a Disston No. 68 Dovetail Saw. Blade extra thin, with fine teeth. The 8" blade, 17 points to inch, is most popular. $1.60.

YOU must have a back saw if you expect to do accurate cabinet work, cut mitres, grooves, mortises, moldings, etc., or do careful joinery. You should also have a bench hook, (below), for holding the work firmly. You can also use a back saw in a mitre box.

In using a mitre box, be sure slots in box line up with the cut to be made. Hold work against back of box and start cut carefully with a back stroke, holding handle slightly upward. After cut is started, gradually level the saw and continue the cut with blade horizontal. Hold saw firmly for clean, straight and accurate cutting.

In using a bench hook, have it at left of cut to be made. In making mortises, tenons, etc., after starting cut, keep saw level and watch depth at both ends. Use a light, even, level stroke. Leave line, or part of line, on the finished work. Use two bench hooks to support long material.

The new Disston Back Saws have heavier backs, to stiffen the blade, keep it straight, and hold the teeth in the cut. Teeth are shaped and set to cut smoother and easier. Blade and handle are balanced to insure better work.

Disston No. 4 Back Saw is made with 8, 10, 12, 14 and 16-inch blades. The 12-inch blade, 3 inches under back, toothed 14 points to inch, is handiest for the home workshop. It costs $3.00.

Good hardware merchants everywhere sell Disston Saws.

DISSTON

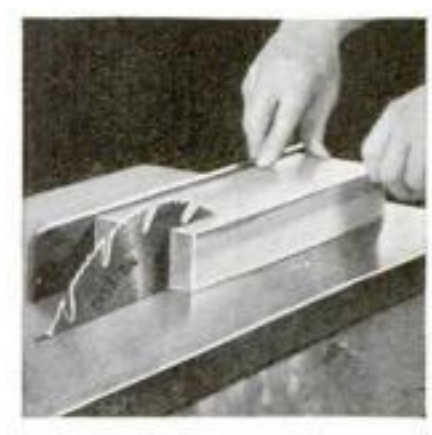
***Makers of* "THE SAW MOST CARPENTERS USE"**

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $3.45. Many other styles and sizes to choose from.

Band Saws for Better Work

Disston "Thin Gauge" Narrow Band Saws are 2 to 3 gauges thinner. They run better on machines with wheels up to 26" diameter. Saw 9' 8" long, ½" wide, 23-gauge, brazed, $2.03. Other sizes in proportion.



For Your Power Saw Outfit

Disston Saws insure better work. Cut easier, stay sharp longer. Disston Circular Saws —cross-cut, rip or combination—are made to fit any make of machine. If your dealer cannot supply you, write to us for prices.

Every saw user will enjoy reading "The Disston Saw, Tool and File Book," an illustrated manual on the selection, care, and use of tools. It tells how to file and set saws, etc., and contains helpful information on band and circular saws. Use coupon, or write.

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Tools That Help You *See* Better

Magnifiers and Small Mirrors Will Save You from Eyestrain and Insure Greater Accuracy—Novel Ways to Use the Camera

By HENRY SIMON

Using a reading glass to follow the progress of a fine cut on a lathe. The holder itself is shown in detail on page 98, Fig. 5.

ALMOST every shop boasts a magnifying glass or two. Occasionally that glass is dug up and used, but generally speaking, mechanics are averse to having anything around of which the "vitals" are glass. Not without good reason, too, for glass and metal don't mix very well.

A more liberal use of optical aids nevertheless is one of the biggest "boosts" a mechanic can give himself. The drawbacks can be overcome, partly by getting used to handling "tools" made of glass and partly by making devices that will allow them to be taken care of easily. Then, too, there is a good deal in a proper choice of these "glass tools," and even more in knowing when and how to apply them.

In magnifying glasses, for example, what is the maximum combination of low price and high performance? A very good team is that of *A*, Fig. 1, page 98—a 4- or 5-in. reading glass with large field and low magnification, and a 10-power glass for detailed work. Do not be surprised to learn that the small 10-power glass, about ¾ in. in diameter, costs twice as much as the large reading glass, because if it is really good, that small glass is composed of three lenses as at *B*.

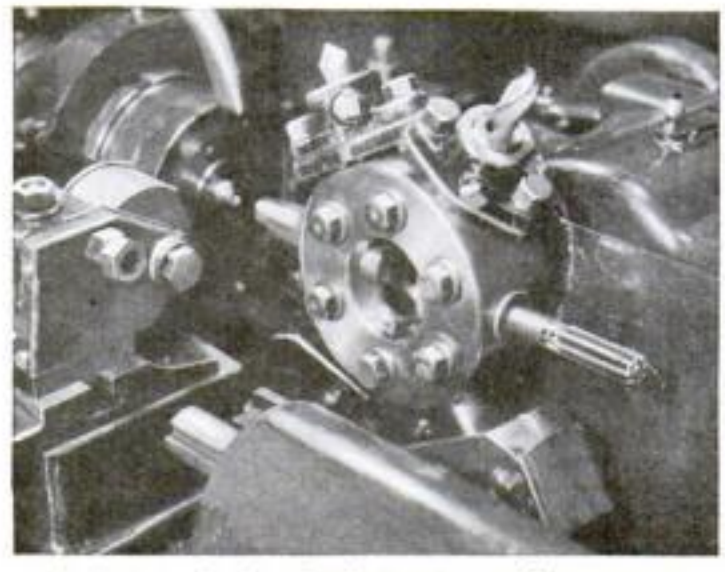
Perhaps the best magnifying glass for all-around use is one marked "6x," meaning that it magnifies six times. It has a fair field of vision, good power, and is always easy to handle. A 14-power glass, on the other hand, will generally mark the useful limit of magnification for shop use.

With any but fairly large and therefore low-power glasses, there is difficulty in keeping them perfectly clean, especially when much oil is used, as in hardening rooms, screw machine departments, and similar places. The oil enters the inner corner of the raised rim and thence spreads over the entire surface, no matter how many times it is wiped off—and the wiping is the more tiresome the smaller is the glass. A homemade mounting for a cheap glass that will do away with this difficulty is shown in Fig. 2 at *B*. It is a plain ring of aluminum or fiber with cupped surfaces that just meet the edges of the lens. The lens itself is a push fit in the fiber ring, and it may be set in varnish in the aluminum one. In either case, the ring should be carefully blackened all over.

An easy-to-clean setting, which protects the lens while in use as well as the standard kind, is that of Fig. 3. The handle may be made of fine hardwood or light metal. The lens setting proper is similar to that just described. The two spring rings guard the glass from damage when it is put down anywhere, but can be instantly depressed to permit wiping off the lens.

A good way to rig up a reading glass for steady use and still allow it to be removed is that of Fig. 4. Placed conveniently in a dark corner of a room, the lamp gives brilliant and even illumination, and no handling of the lens is necessary.

Did you ever follow the progress of a fine cut on the lathe with a reading glass? If not, try it the next time you have one of those superfinicky jobs, and see how much nervous tension it will save you and how it will speed up some kinds of work by eliminating guessing. The glass may be held by hand, or you may rig up an easy-to-put-on and easy-to-take-off holder right on the tool post, as in Fig. 5. Besides giving you a picture of the cutting operation such as you cannot get otherwise, this arrangement will also guard your eyes from flying chips.



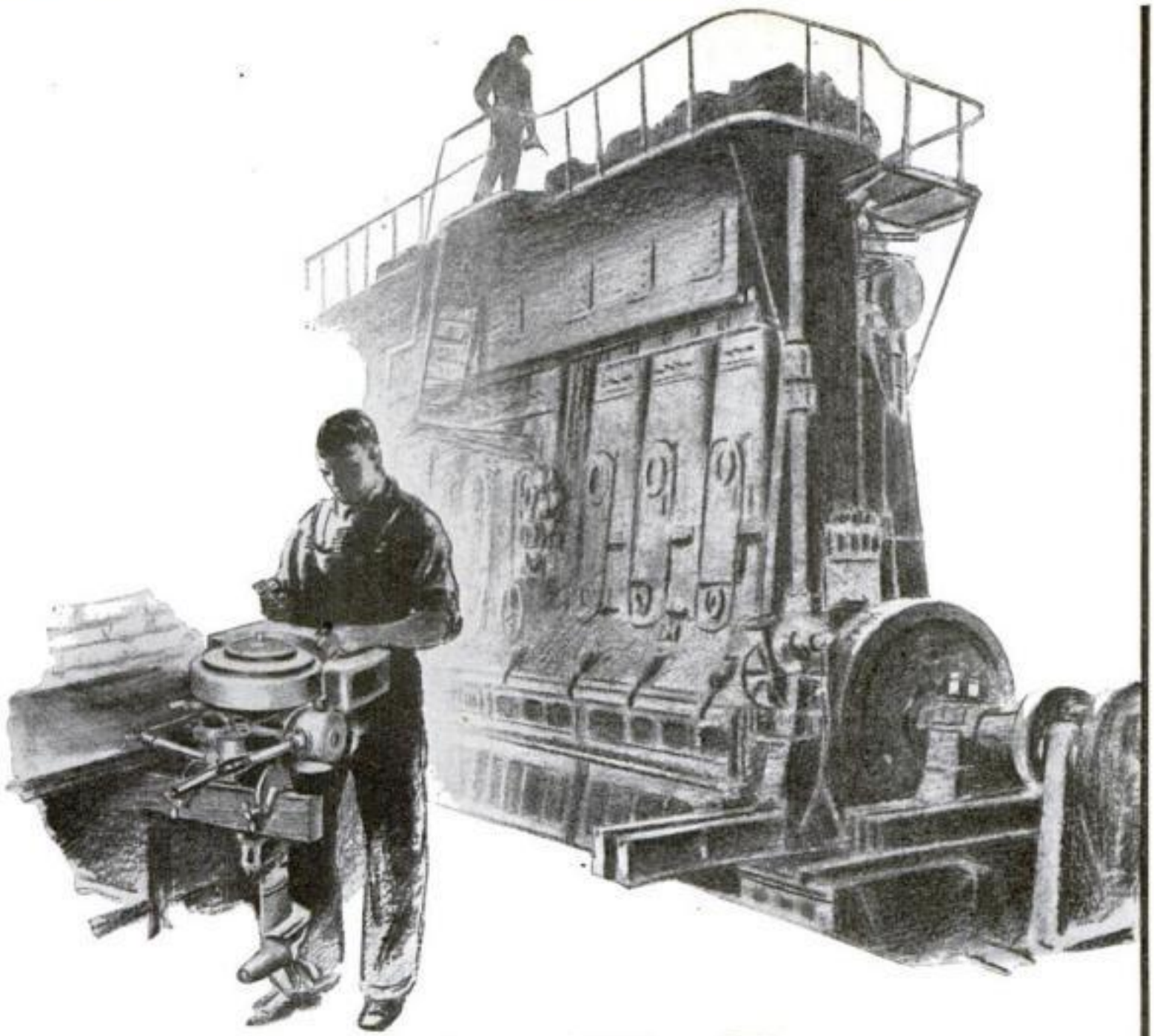
A photograph of an intricate set-up makes a permanent record in case you have to duplicate the work.

At *A*, Fig. 6, is shown a headgear made of wire, which obstructs very little of your ordinary vision. At *B* is illustrated the same idea applied in the shape of a clip for an eye shade; in this case the holder also forms a handle when it is desired to use the lens by hand. Finally, there is a very convenient rig for those who wear glasses in the clip at *C*.

HAVING good magnifying lenses is one thing, but proper illumination and the right way of viewing objects is another and hardly less important consideration. Good sunlight from the correct angle is usually the best illumination, but it is not always to be had. The light of an electric lamp, properly used, is on the whole preferable.

The background against which the object is viewed is another point. The poorest background is a neutral or nonuniform one; black and white are equally good if it is remembered that the illuminated edge—usually the upper edge—of an object should be viewed against black, and the unilluminated or lower edge against white, for the reasons appearing in Fig. 7. You may save a lot of eyestrain by remembering this simple point, especially in viewing threads.

By the way, how should a thread be viewed; as at *A*, Fig. 8, or as at *B*? It is remarkable how many misconceptions there are in regard to this point. Without going into the "why's," there is no difference with any ordinary screw thread in which of the two ways it is viewed—at least when the viewing is done "by hand." With steep threads, which may be either multiple or threads of heavy lead, the viewing should always be in the direction of the helix angle, as at *B*, for the reasons which are made clear in the drawing. It is well to remember on general principles (*Continued on page 98*)



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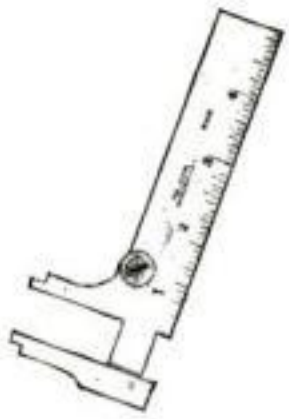

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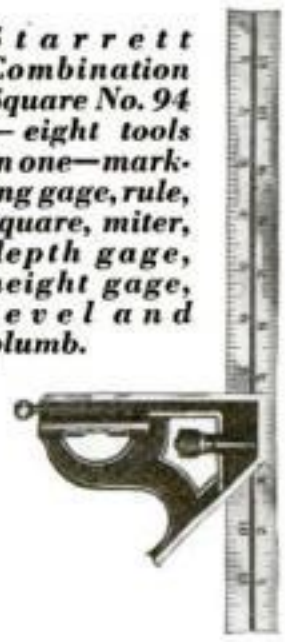
The popular No. 436 Starrett Micrometer in one inch sizes up to 12 ins. and in sets. Furnished with or without lock nut, ratchet stop and half thousandth divisions.

Starrett Combination Square No. 94 — eight tools in one—marking gage, rule, square, miter, depth gage, height gage, level and plumb.



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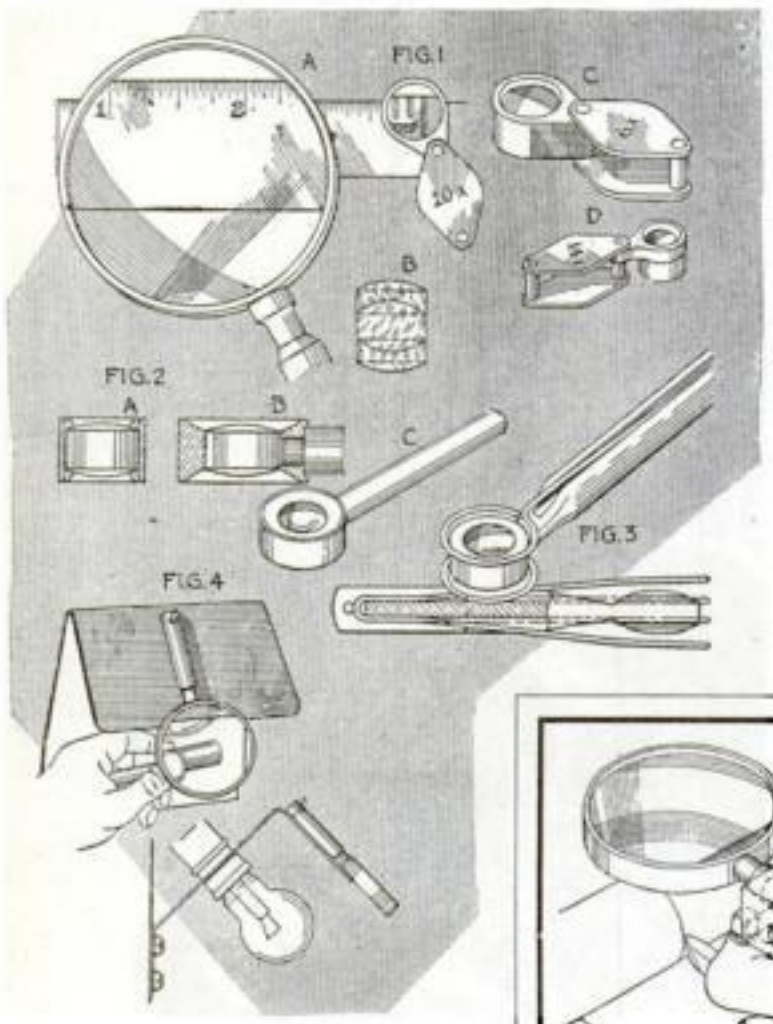
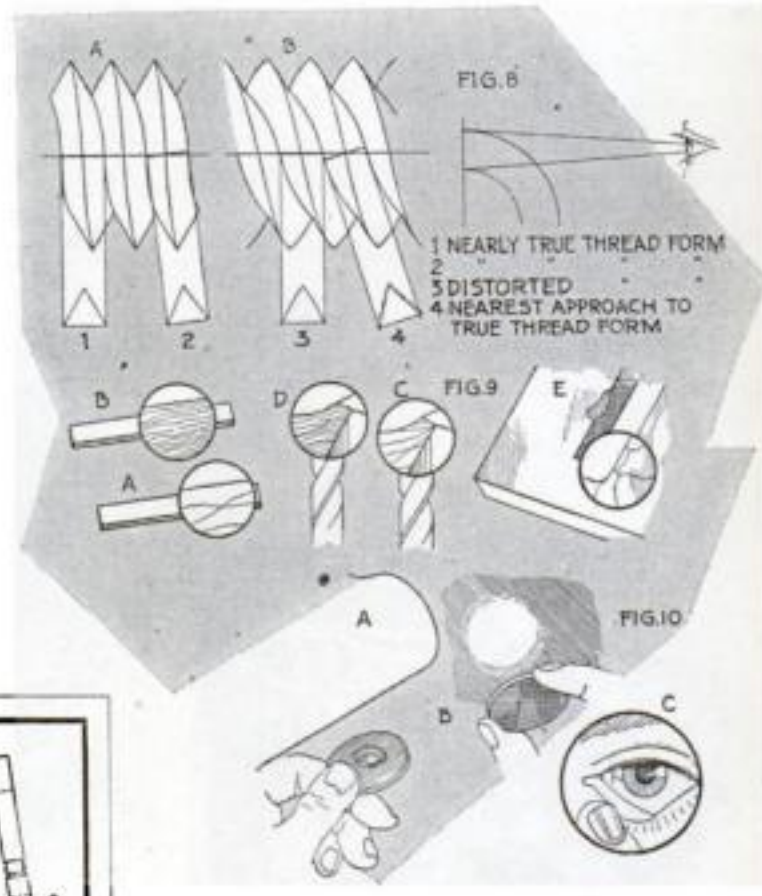
Tools That Help You See Better

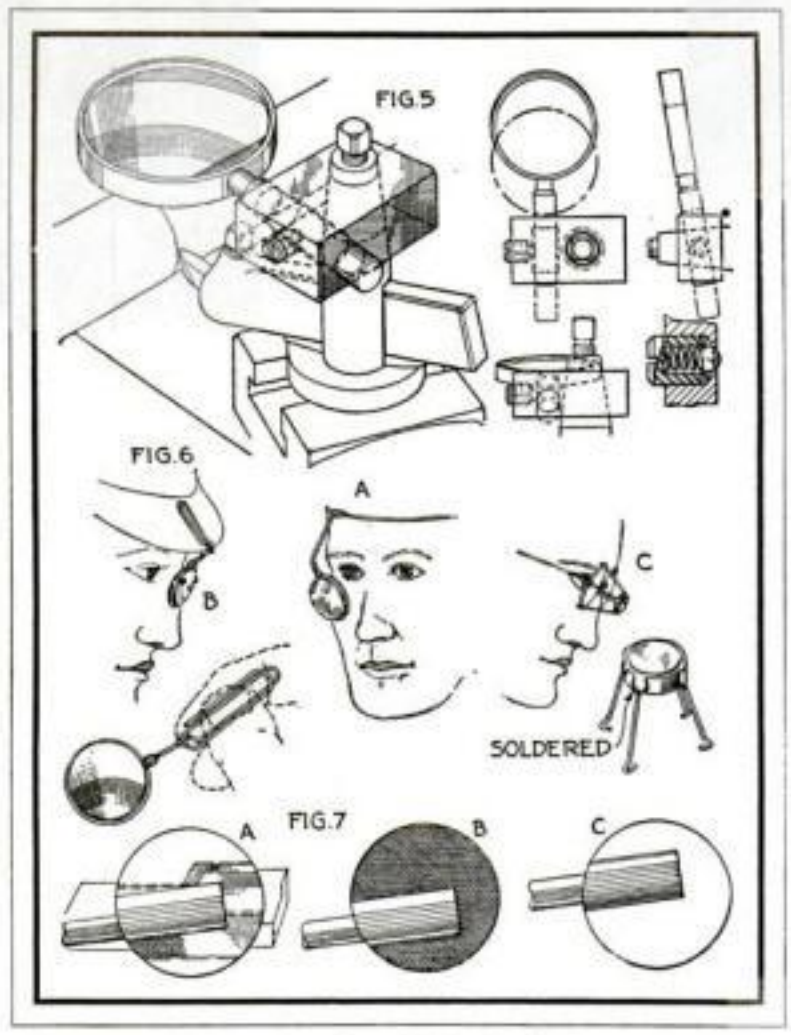
(Continued from page 96)



Figs. 1 to 4. Magnifying glasses used in the shop; settings and holders; reading glass hung on light shade.



Figs. 8 to 10. Various ways to study a screw thread; defects revealed by magnification; uses for a mirror.



Figs. 5 to 7. Reading glass holder for lathe; wire lens holders; backgrounds for magnified objects.

that although optical projection is an excellent way of checking screw threads, no point of view can ever give the exact theoretical outline of the thread.

The mechanic who once makes up his mind not to pass by the benefits offered by optical instruments will find many further uses for the magnifying glass, some of which are suggested in Fig. 9. Looking over the cutting edges of a reamer or tap through a 10-power lens will give a new idea of the importance of having tools sharp. It will explain why the highly-finished gaging or wearing surface at *A* will last several times as long as a poorly-finished one at *B*. It will solve the puzzle of why, by merely putting a high finish on the surface of the cutting edge on a drill or bit as at *C*, it can be made to outlast the one at *D*, sometimes six to one. It will show cracks in hardened parts, such as the die at *E*, and explain the cause of failure of many a hardened, rolled, or forged piece.

Second in rank among the optical helps for the mechanic is the mirror. This may be either plane or convex and magnifying.

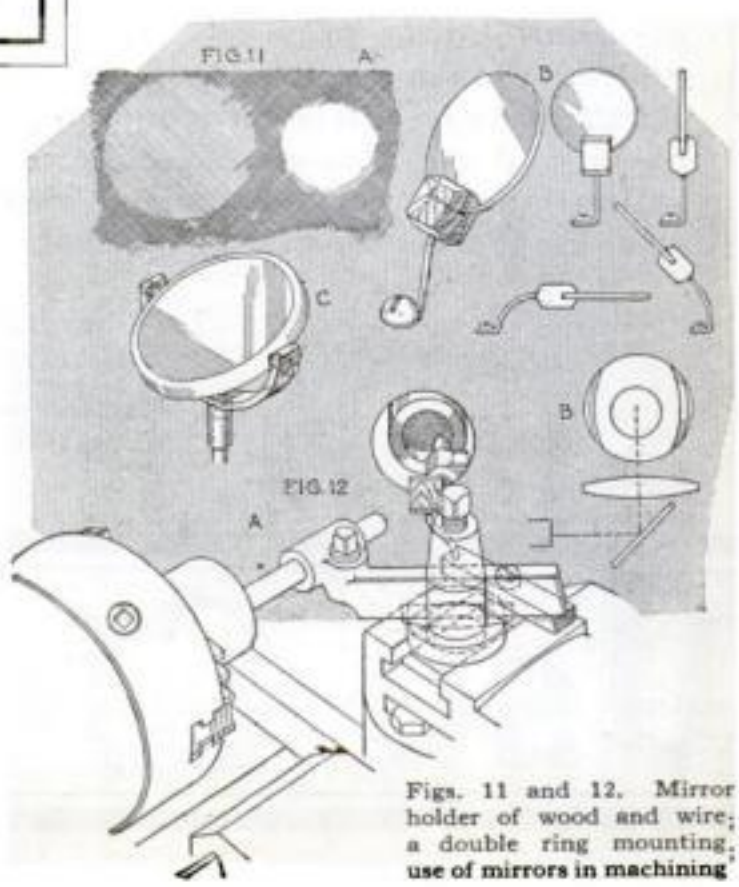
Before you kink your neck the next time in a vain attempt to find what is the matter with some inaccessible part of a machine—as, for example, the underside of a projecting arm—see if you can't save time and trouble with the help of a fifty-cent pocket mirror, as suggested at *A* in Fig. 10. A mirror of similar size, but of the convex or magnifying kind, will be equally handy in concentrating a beam of bright light on some corner or recess when a flashlight is not on hand or where the space is too small to use one, as shown at *B*. And incidentally, such a magnifying mirror is a mighty good "first aid" accessory when something is in your eye, as suggested at *C*.

One of the best uses of mirrors, either plane or concave, is for the steady illumination of fine scales on machines or instruments which are otherwise hard to read.

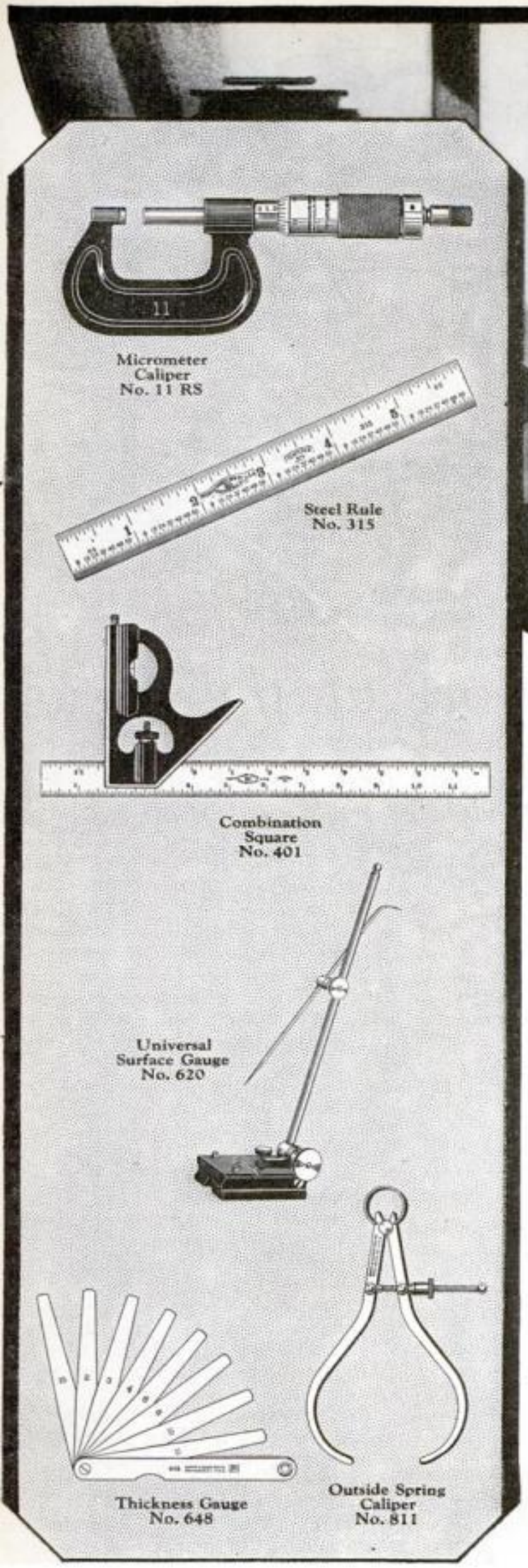
Here the mirror has the advantage of putting the light exactly where it is wanted, yet without occupying much space. As indicated at *A* in Fig. 11, a plane mirror will illuminate a certain surface, while a concave one will give greater intensity of light on a smaller area.

Whichever is used, it is essential to have some readily adjustable mounting for the mirror. A cheap and quickly made one is that at *B*, improvised from a small block of hardwood and a piece of soft copper wire. By turning the block and bending the wire, the mirror may be instantly adjusted to any angle. A more permanent mounting, but one which is also more trouble to make, is the double ring at *C*.

A plane mirror occasionally may be rigged up with good effect on the lathe or miller to aid in some delicate finishing operation, as illustrated by the example at *A*, Fig. 12. Another mirror may be used to light (Continued on page 123)



Figs. 11 and 12. Mirror holder of wood and wire; a double ring mounting; use of mirrors in machining



Wherever Measurements Are Reckoned in Thousandths — and Finer

IN present day precision work where accuracy is figured in terms of thousandths—even ten thousandths of inches only the finest tools can stand the pace.

To meet the demands of skilled mechanics for accuracy in tools, Brown & Sharpe has long produced precision tools which comply with the most rigid standards. It is a tribute to this effort that Brown & Sharpe Tools have become known as the "World's Standard of Accuracy."

Micrometer Depth Gauge No. 607 shown above is a particularly serviceable and handy tool. It is furnished with three measuring rods which give it a range from 0 to 3″ by thousandths. This tool as well as over 2300 others are shown in the new Brown & Sharpe Catalog No. 31. Ask your hardware dealer for a copy or write to us for one. Address Dept. P.S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

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The seashore is doubly delightful when you have adequate beach furniture and protection from the direct sunlight

More Comfort *at the* Beach

How to Make a Back Rest, a Sand Table, and a Sun Shelter or a Parasol Holder

By HI SIBLEY

IDLING all day on the sands is a fine recreation if one does not have to pay for it in sunburn, a lame back, and gritty sandwiches. These drawbacks can be avoided by making beach furniture of the kind illustrated.

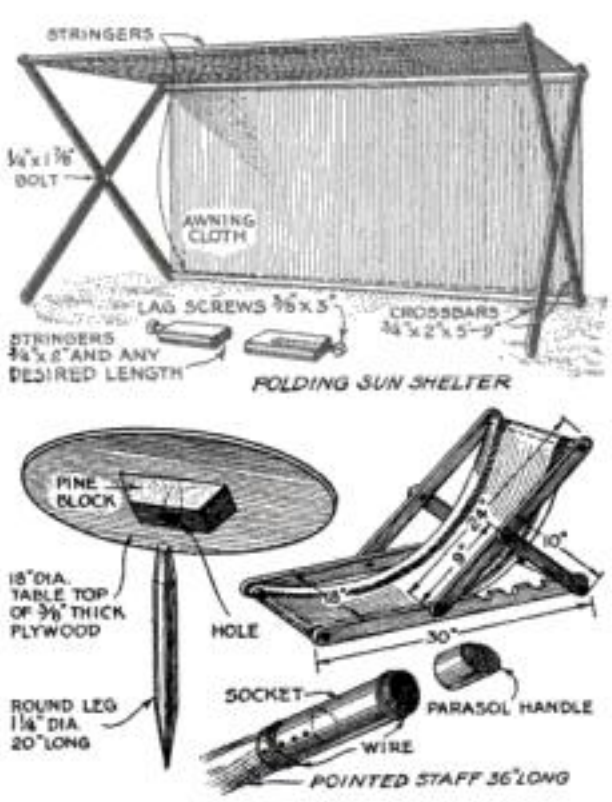
The back rest is one of the greatest comforts. Essentially a steamer chair minus legs, it is so easy to make one cannot afford to be without it. White pine is desirable for the side members because of its light weight, and it will be found strong enough for the purpose. Before assembling the framework, slip the round cross members through the hemmed ends of the cloth, which can be purchased from an awning manufacturer. A piece about 16 by 52 in. is required.

As a standard beach umbrella is expensive, you can save money by making a staff with a socket to support any straight-handled parasol available—for example, a Japanese parasol, which is light and durable. A section of brass tubing of the desired diameter is ideal for the socket, but lacking this you can make one from a piece of sheet brass, copper, galvanized iron, or even tin.

The little beach taboret is handy for keeping food, beverages, or sewing basket out of the sand. Fasten the pine block on the underside of the plywood top by driving finishing nails through the top. A section of broomstick or any round stock will serve for the leg.

For protection from sun, wind, and sudden showers, a folding beach shelter is always useful. The principal expense is the cloth. Ordinary unbleached muslin will bring the investment down to a minimum. Bolt the crossbars so that they can be folded together and rolled up in the cloth, together with the 6-ft. or longer stringers.

From personal experience, I recommend painting all woodwork some bright color, such as red, blue, or green, for on a crowded beach there is so much other equipment and often driftwood of a neutral color that it is not always easy to locate your own property, once you wander away from it.



Folding beach equipment which can be made with little difficulty and at trifling expense.

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Ray Kutterer, a Universal student who now holds a responsible position with the Universal Aviation Corporation.

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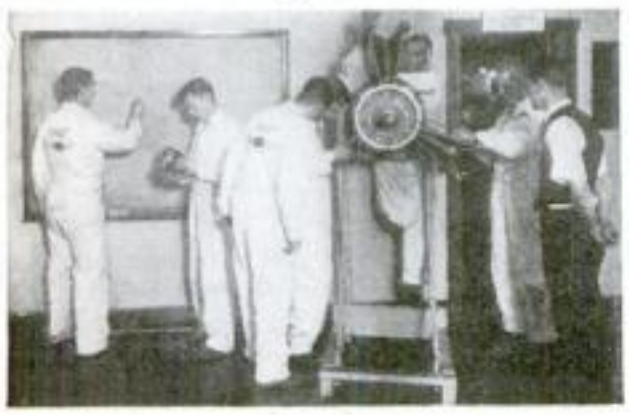
Graduates of the Universal Aviation Welding Course are always in demand.



Universal students taking the Aviation Mechanic's Course work on all types of motors including latest air cooled makes.

courses and high type of training. These schools are owned and directed by the Universal Aviation Corporation, a concern which, with its affiliated lines, covers over 17,500 miles of airways a day carrying air mail, express and passengers. Having the tremendous resources of the Universal Aviation Corporation behind them, the schools have been provided with the finest equipment obtainable and the most competent instructors in the country.

book is interestingly written, truthful in all respects, full of illustrations and honestly helpful to you in planning a way to enter this field of big, new opportunities. Send for your copy—FREE—today.

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Fishermen's Knots

By WALTER E. BURTON

SUCCESS or failure in fishing is often a matter of knots and hitches. Those who have experienced the disappointment of having a prize catch—or one that looked like a prize—dash away with the bait simply because a supposedly secure knot had slipped will understand the truth of this statement.

Every angler should know the best methods of splicing or forming loops in his lines, leaders, and snells. While there are eight different knots that cover all of the ordinary demands of fishermen, two or three are of outstanding interest and should be used in preference to others when possible.

For forming a loop on the end of a line or snell, there is nothing better than a compound knot (Fig. 3), according to one of the leading authorities on fishing tackle. Of course, you can use the simple loop knot that everyone knows how to tie, but it is not quite

(Continued on page 118)

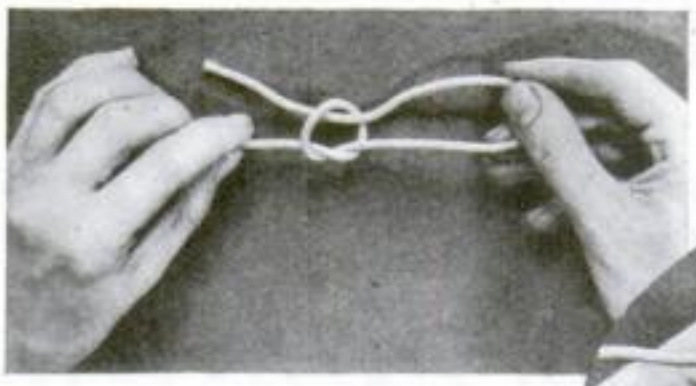

Fig. 1. In tying a compound loop, an ordinary running knot is first formed. Heavy cord has been used for clearness.

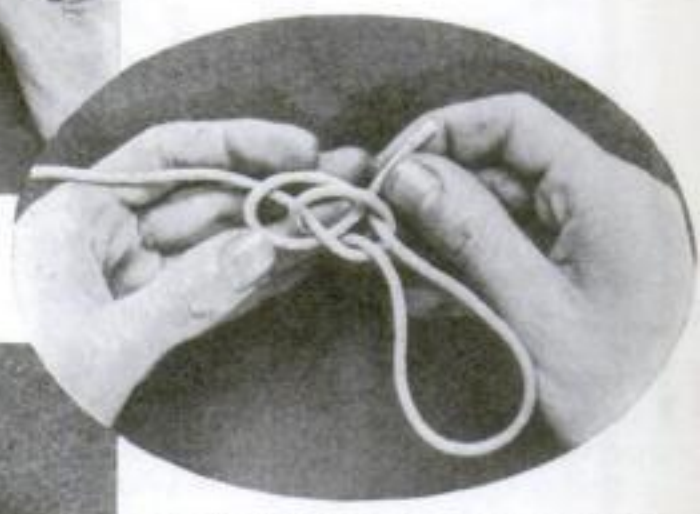

Fig. 2. The free end is looped over the main cord and over a part of the first knot made; then it is carried under the remaining parts.

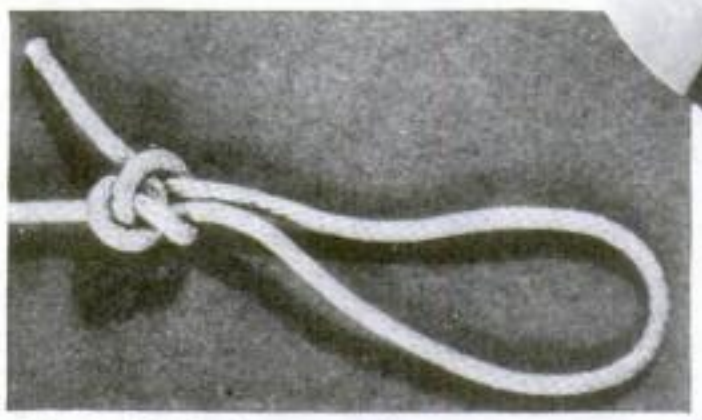

Fig. 3. This is the compound knot when drawn tight. It will not slip or break easily. Fishing experts have found it superior to the well-known bowline because the line is bent less sharply when forming the knot.

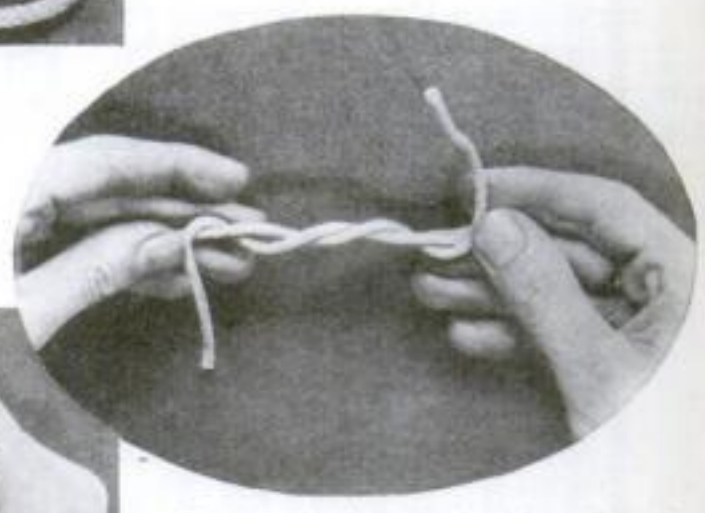

Fig. 4. The first step in tying a knot in gut leaders is to carry each end twice around the other in opposite directions.

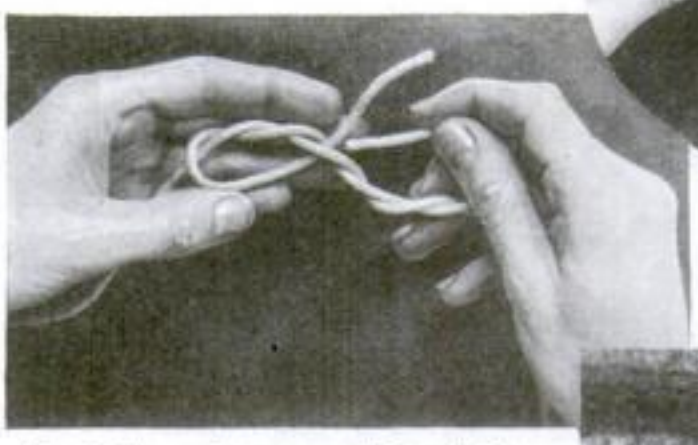

Fig. 5. The ends are passed through the central twist or opening; one is shown through, the other about to go through.

Fig. 7. An excellent hitch for attaching a line to the loop of a leader.

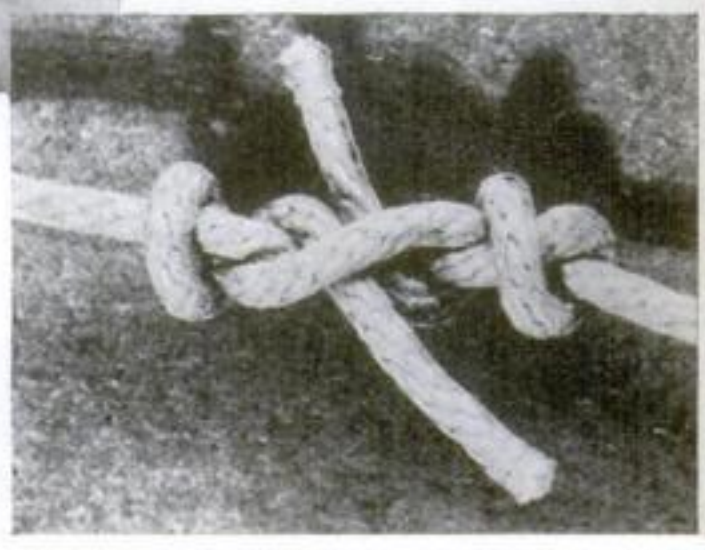

Fig. 6. The twist knot when pulled tight. It is considered by many anglers as the best knot of its kind.

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Reproducing *an* Old Chair

You Will Find It Easy to Build This Charming "Ladder-Back" Even If You Do Not Own a Lathe

By FREDERICK J. BRYANT

THIS "ladder-back" chair, which takes its name from the arrangement of the slats forming the back, is a good specimen of some of the earliest chairs made in this country. Chairs of this type, because of their decorative appearance and Colonial associations, are popular and in demand for use in a hallway, living room, or bedroom. They are not, it must be admitted, especially comfortable.

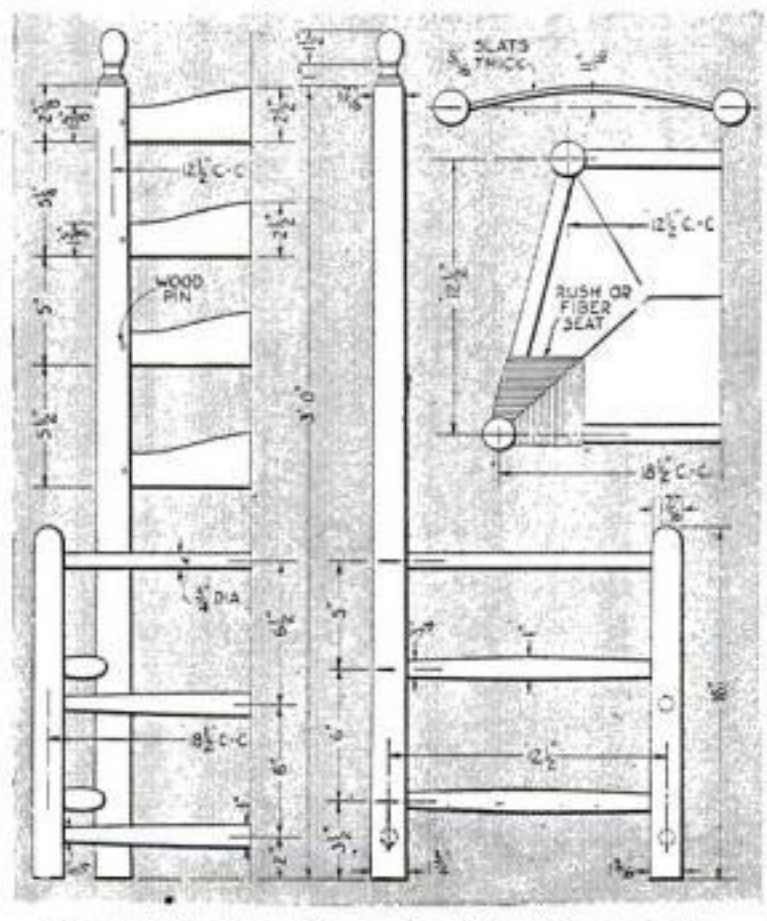
The design illustrated was chosen because it is not difficult to copy. The back legs are plain except for the upper ends. The irregularly shaped knobs may be part of the legs or turned separately. Another feature is the fact that this chair can be made without a lathe.

Handmade reproductions of this type of chair are highly prized for their decorative quality and antique look.

It may be well to cut and fit the mortises before rounding over the legs by hand or turning the stock in a lathe. If the stock is left square until the slats are fitted into place and the holes are made for the rounds, it is a simple matter to lay out the work.

Soft pine fillers can be placed temporarily into the mortises if the legs are to be turned. The fillers will prevent chipping near the edges. All of the mortises and holes should be about ¾ in. deep. Wooden dowels or pins are used to strengthen the slat joints.

To make the back legs by hand, plane the stock exactly square with the base 1¾ in. and the top 1 7/16 in. On the larger end measure in from each corner exactly ½ in. Connect these points cornerwise and you will have laid out an eight-sided figure—an octagon. Do the same on the smaller end, measuring 7/16 in. instead of ½ in. With the aid of a straight stick, draw lines the full length of the posts to connect these corner measurements. Now plane or bevel the corners of the leg, being careful not to cut below the bevel lines. All of the bevels should measure about ⅝ in. wide at the big end.



Measured drawings of a genuine Colonial ladder-back chair of excellent proportions and unusual simplicity.

AS THE next step, remove the remaining corners with a plane. The knobs at the top can be omitted if necessary. After this comes the scraping, filing, and sandpapering. The front legs are made in the same manner.

The seat rounds are ¾ in. in diameter, and on them is woven the rush or fiber seat. Rush was used on the original, but fiber is easier for the amateur to handle. Simple printed directions are usually given with the fiber when it is purchased.

The chair rounds below the seat are ¾ in. at the ends and 1 in. in (Continued on page 119)

How *to* Drain *Your* Ice Box

Two Easy Ways to Install Piping That Does Away with the Nuisance of Emptying a Pan

By EVERETT EAMES

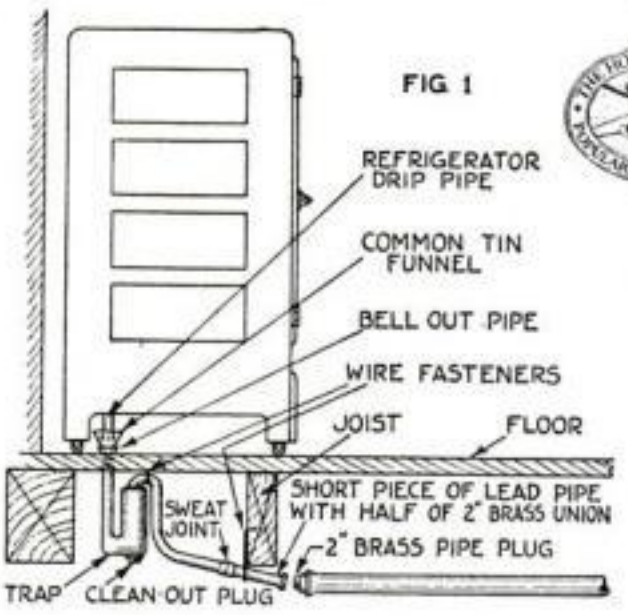


Diagram showing trap and piping beneath floor ready to be connected to the house drain.

MANY refrigerators which use ice are allowed to drip into a pan in the old-fashioned way. Anyone who has tried to empty one of these brimful pans and has mopped up afterwards realizes that there is much to be desired in the arrangement. But when the ice box, like the Arkansas traveler's leaky roof, is in use, you cannot fix it; and when it is not in use, it does not need fixing. Why not be a little forehanded and get rid of this nuisance by making a permanent pipe connection for the disposal of the drip water?

There are two desirable methods of accomplishing this. One depends somewhat on the foresight of the plumber who piped your home, and whether he has left an opening at one or more of the bends in the 2-in. pipe that carries away the water from the kitchen sink. This opening will be found closed with a brass plug.

To connect the refrigerator with this outlet, first buy a new lead trap or obtain an old but renovated one from a plumber. A short piece of lead pipe with half of a 2-in. brass union on one end, and enough extra lead pipe to reach the overflow end of the trap, as shown in Fig. 1, also will be needed.

The trap can be fastened to the floor by means of heavy wires. Its upper end should be belled out slightly with a ball peen hammer after it has been passed through a hole drilled for the purpose in the floor. The refrigerator drip pipe discharges through a funnel into the lead waste pipe, thus providing a flexible connection between the two.

The other method is to pass a lead pipe through the floor and allow the water to drip into a rectangular copper pan (Fig. 2). The pan is set at a slight angle and is drained by a 1-in. lead pipe, which passes through a hole drilled through the rear wall of the house. Sometimes the water can be allowed to drip directly into a flower garden, or a watering can may be kept under the pipe.

The object of using a pan is to provide a convenient method of catching the slime and waste particles released from the melting ice, which in time would clog the pipe. A trap of No. 30 brass or copper screen should be soldered across the inside of the pan just in front of the outlet, as shown in Fig. 3.

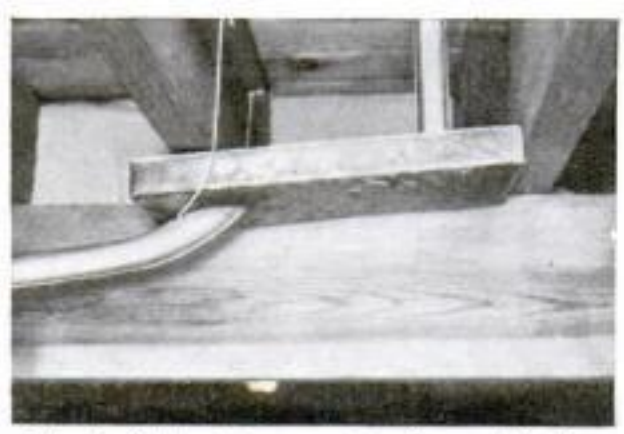


Fig. 2. Sediment pan under floor with pipe which leads outside through the foundation.

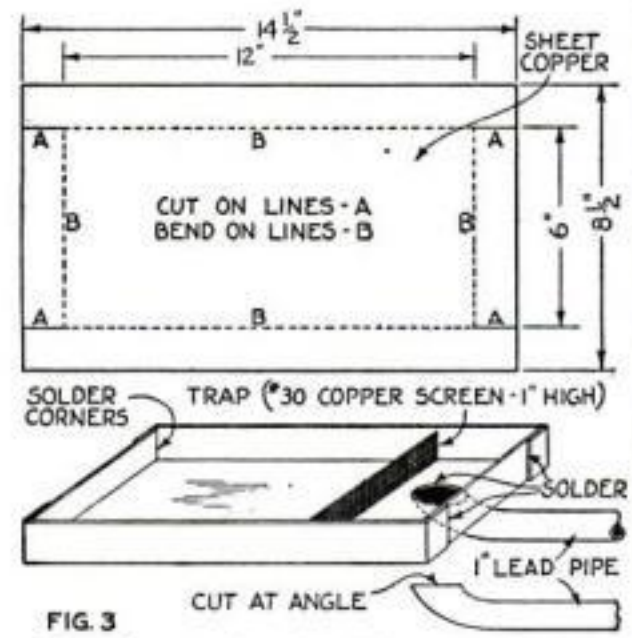


FIG. 3

How the pan is made and provided with a screen to keep all the sediment from the pipe.

The method of constructing the pan and making the joint between the pan and the pipe should be studied before the metal is cut. When placed as shown, the screen is not likely to be clogged, but even if it is, water can run over it into the compartment with the outlet. It will be noted, too, that the pipe is bent and sawed off at an angle before being soldered to the bottom of the pan.

The reason a pan cannot be used in the first method is that any opening (except the roof vent) which is even remotely connected with a sewer, as in the case of a sink run-off, must be water-sealed, as by a trap. Any cleansing necessary can be accomplished by removing the plug at the bottom of the trap.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

THE home workshop chemist can gage the moisture content of the atmosphere with considerable accuracy by making a contrivance for which the essential materials are a sheet of white filter paper and a small quantity of chloride of cobalt. Less than half a dram of the chemical dissolved in half an ounce of

Using water colors to prepare a tinted scale for comparison with the impregnated filter paper. The completed moisture-measuring instrument is at the right.

water (or as much as you can pile on a five-cent piece dissolved in two teaspoonfuls of water) is sufficient for one sheet of filter paper.

Pour the solution in a flat-bottomed developing tray; then fold the filter paper until it is small enough to fit the tray and place it on top of the liquid. The paper will quickly absorb the solution and will assume a beautiful rose color. After one minute or more, when the paper is evenly colored, remove it from the tray, unfold it, and let any excess solution drip back into the tray.

Hang the wet paper over a horizontal glass rod, or pin it to a narrow strip of wood, leaving it thus in a warm place until it is dry, when the color will no longer be rose red but a rich and beautiful blue.

It is this remarkable change of color which makes it possible to measure with considerable accuracy the moisture content of the atmosphere. In dry air the paper will retain the vivid blue color, but the greater the percentage of moisture in the air, the more will the color of the paper change from pure blue to rose color.

For ordinary purposes the observation of the tint of the paper will indicate with sufficient accuracy the percentage of moisture, but where greater accuracy is required, it is necessary to employ a more exact method. Provide yourself with a long strip of white, smooth drawing paper, about *(Continued on page 122)*

On *the* Hunt *for* Old Lights

If You Can Lay Hands on a Good Looking Gas Lamp, Discard the Burner and Wire It for Electricity

By HAROLD P. STRAND

Attractive electric table lamp made from an old and supposedly worthless gas burner.

TO CONVERT an old gas lamp into an electric lamp, you will need the following materials, which can be purchased from any well-stocked electrical supply store: a two-light cluster and stem, two pull chain sockets, an attachment plug, silk parallel cord of the required length, a ⅛-in. hard rubber bushing, and 2 ft. of bead chain.

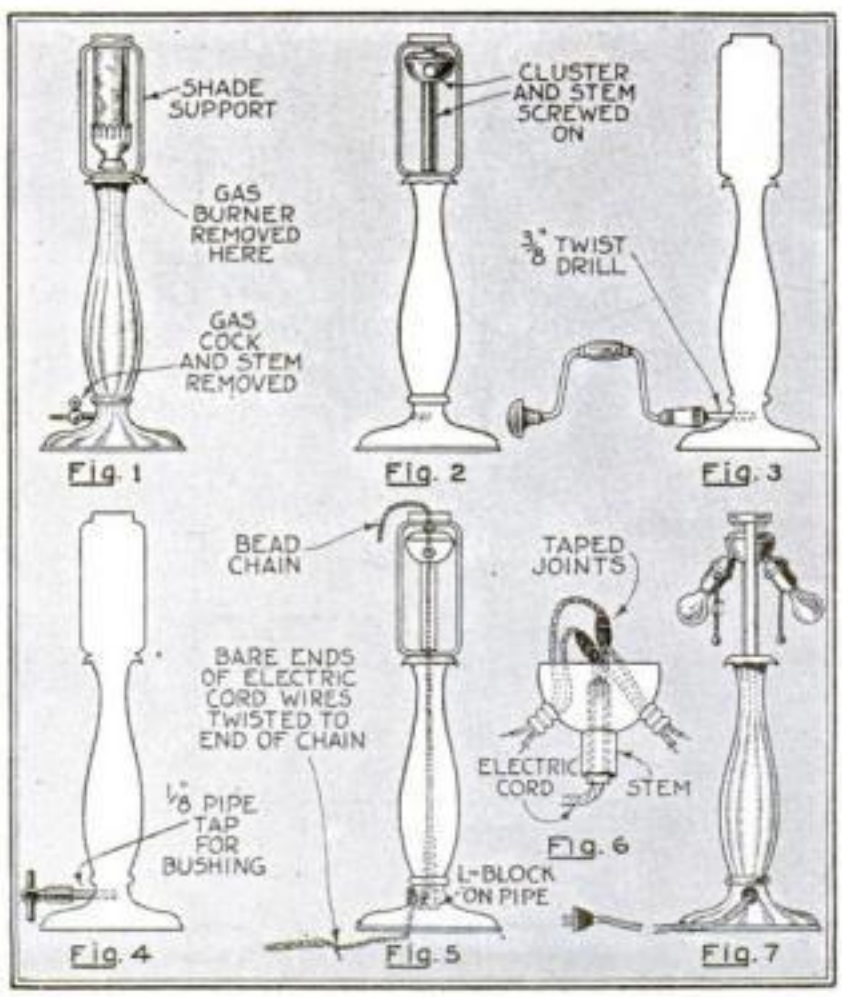
The necessary tools are a ⅛-in. pipe tap, 5/16-in. drill, tap wrench for holding the tap, pair of pliers, small screw driver, jackknife, gas pliers, and a bit stock. The step-by-step operations are shown in the drawings below.

After lifting the shade from its support, unscrew the old gas burner (Fig. 1) by placing the pliers just beneath the adjusting wheel and turning to the left. Remove the gas cock and stem with the pliers; it may be that it is cemented in with a sealing compound or solder, in which case apply heat from a torch, taking care to keep it away from any finished surface which may be marred. In this operation the lamp is usually turned upside down and the heat applied to the L-block into which the stem screws.

Now screw the cluster and stem on the end of the pipe at the top of the stand (Fig. 2). With the 5/16-in. twist drill (rather than ⅜-in. as in the drawing), ream the hole through the base as in Fig. 3 to reach the vertical hole in the stand or upright. Place the tap in the tap wrench and carefully cut some threads in the hole (Fig. 4) to secure the bushing, which follows next.

Drop the bead chain into the top of the lamp through the cluster and shake it down through the center of the lamp and out at the bottom. Then trim one end of the lamp cord bare with the knife and twist the strands together, both wires into one cable. Wrap this wire around the bead chain (Fig. 5), making the joint as small as possible and yet sufficiently strong. Pull the cord up through the lamp by means of the bead chain. A little difficulty may be experienced in getting the joint to pass through the bottom end, but by making a careful twist it will go. Some of the outer silk covering of the cord, if of a thick variety, may have to be removed.

The connections to the sockets at the cluster are made by cutting the cord clean from the bead chain and splitting the outer silk covering with the knife for about 3 in. At a point 1½ in. from the end of each wire, scrape a bare spot about ½ in. long. Take two short pieces of wire, scrape the ends bare for 1 in., and wrap each one on the bare spots on the cord, tightening the joints with the fingers. Apply some flux and solder the joints. Wind them with both rubber and friction tape, keeping them as small as possible (Fig. 6). The socket caps are now screwed on, the connections made to the contact screws, and the shells snapped in place. The other end of the cord is carried out through the bushing and the attachment plug connected to its end. The completed lamp (except the shade) is shown in Fig. 7.



Diagrams showing step by step how a two-light electric cluster and stem are substituted for the burner of an old table gas lamp.

Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

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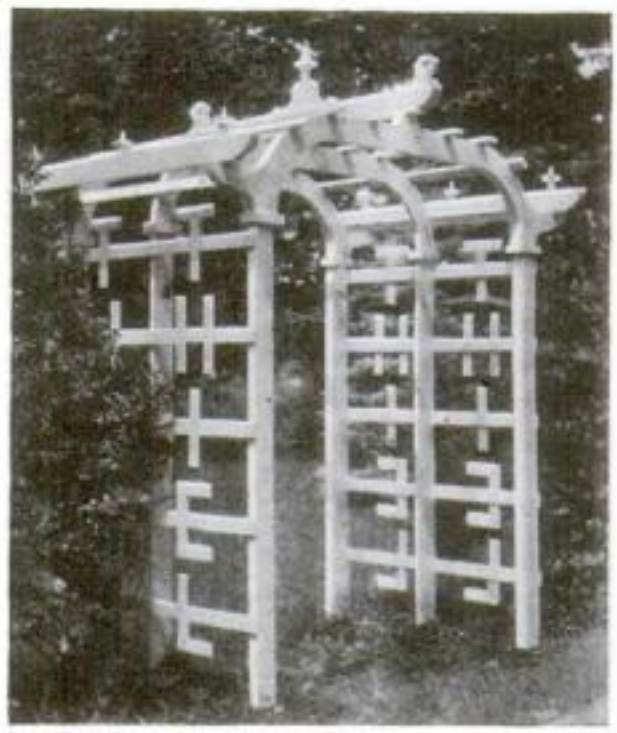
Building Garden Woodwork

ARBORS and pergolas are a step in advance of the simple trellises and fences described in the July issue, but they enhance a garden greatly and well repay the amateur woodworker for whatever effort he makes in designing and constructing them.

The pergola illustrated was built by Charles Thiel, of North Andover, Mass., a reader of POPULAR SCIENCE MONTHLY. Not only did he work out an unusually attractive design for the upper part of the pergola, but he arranged the latticework in a pattern to spell his name, as a close inspection of the photograph will reveal. This was such a novel idea that it attracted much attention in his neighborhood and has been copied by other craftsmen.



Pergola constructed by Charles Thiel in such a way that the latticework spells his name.

Another type of substantial arbor—one with two seats and a garden gate—which has been built with much success by readers is shown completely in POPULAR SCIENCE MONTHLY Blueprint No. 9, which can be obtained for twenty-five cents (see the list on page 109). Besides the usual assembly views and a complete bill of materials, this blueprint contains a full size pattern of one half the top curve and other full size details, making it very easy to work from.

Designs and bills of materials for several trellises of a more elaborate type than those illustrated last month are contained in Blueprint No. 34. On this sheet is also an interesting sundial support built of wood in trellis fashion. Indeed, this sheet is so filled with helpful suggestions that anyone planning to build trellises will find it an aid in deciding the best arrangement for his own particular purposes.

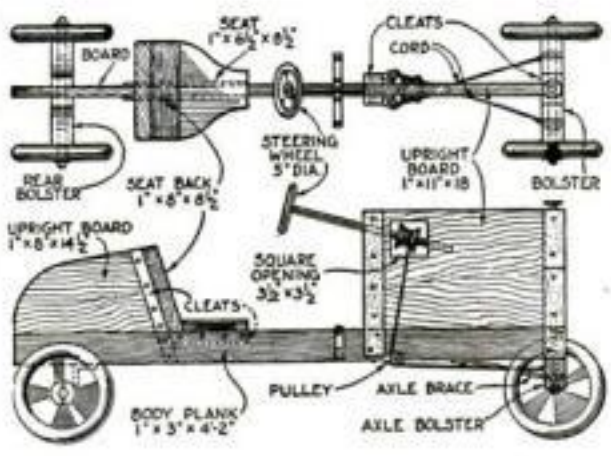
An especially graceful wooden porch swing is completely detailed in Blueprint No. 10 and is a good project where oak, ash, or other hardwood can be obtained at a reasonable price.

Another piece of attractive and easily made furniture for the porch, garden, or breakfast room is the bench and tilt-top table of Blueprint No. 11. Normally the piece is used as a bench and has a roomy compartment for storage under the seat. When a table is desired, the back is tilted forward and forms a rectangular top 2 ft. 6 in. by 4 ft. 6 in.

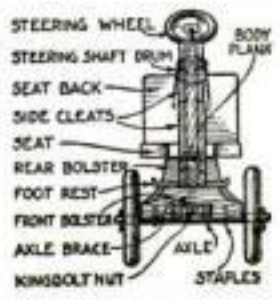
Toy Foot-Propelled Auto for Small Child

FREQUENTLY it happens a little fellow of from two to four or five years old wants an auto "just like Daddy's" when he is too small for factory-built, foot-pedal-driven models. Then, too, these models are expensive for many pocketbooks. Both considerations had some bearing on the design and building of the car illustrated.

A colorful homemade car for a boy not big enough to operate a pedal-driven machine.



Working drawings of the toy auto the original model of which was constructed in the Mishawaka (Ind.) High School shops. The steering wheel is turned from 1-in. stock, but a ready-made substitute could be used. The car is painted brightly.



Any kind of wood that does not split easily will do for the wooden parts. The axles, kingbolt, and tie-rod are made of mild steel. The wheels may be purchased from a manual training supply house or taken from an old wagon or other toy, if one is available. To connect the steering wheel with the axle, a heavy cord will do, but a piece of ⅛-in. stranded steel cable will be better and last longer. Notice that the cords cross under the car.—H. R. GOPPERT and E. SPRAGUE.

Motor Wheel Drives Boy's Coaster

In spite of rough pavements and heavy loads, this little auto has given excellent service.

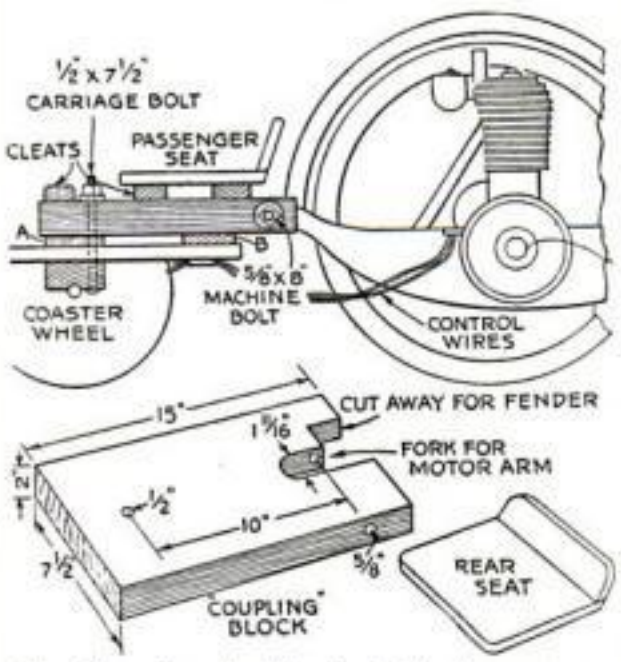
FOLLOWING the publication of an article on making a homemade coaster in the July issue of last year, many inquiries were received asking how power could be applied to the little car.

The most practical plan is the use of a standard motor wheel such as are manufactured for attaching to a bicycle. This has the advantage of being a compact, self-contained unit, relieving the coaster of any additional weight.

The only alteration required in fitting the wheel to the coaster as originally illustrated last July is the removal of the dummy gas tank. The coupling for the two units is merely a block of clear yellow pine or oak sawed to fit the front end of the motor wheel, with a vertical bolt up through the forward end. A horizontal bolt secures the motor wheel to the fork at the rear end of the wooden block. The fork should be just wide enough to take the front motor support with washers on each side. This is important, for if there is any side play the motor wheel will tend to wobble when in motion.

After removing the dummy gas tank, nail or screw a wooden crosspiece or cleat 1 by 3 in. by the width of the body over the rear axle (on top of the main body board) and a similar piece on the end of the board (see *A* and *B*). Then bore a ½-in. hole through the axle block to receive the bolt.

A rear seat fastened to the coupling block will not interfere with operation and there is plenty of power to carry an extra passenger. A "mechanic" is handy, too, for a motor of this type must be pushed to get started, and it is awkward for the pilot to do this. The car can be stopped within a few feet in an emergency.—H. S.



How the motor wheel is attached to the coaster. The control wires are carried to a convenient block extending from the right side of the car.

Every hunter likes to keep his shotguns and rifles in a dust-proof cabinet where they are well displayed and always accessible.

How *to* Make *a* Gun Cabinet

It Is Ornamented in Hunter's Fashion and Has Space for Displaying Four Firearms

By R. L. READY

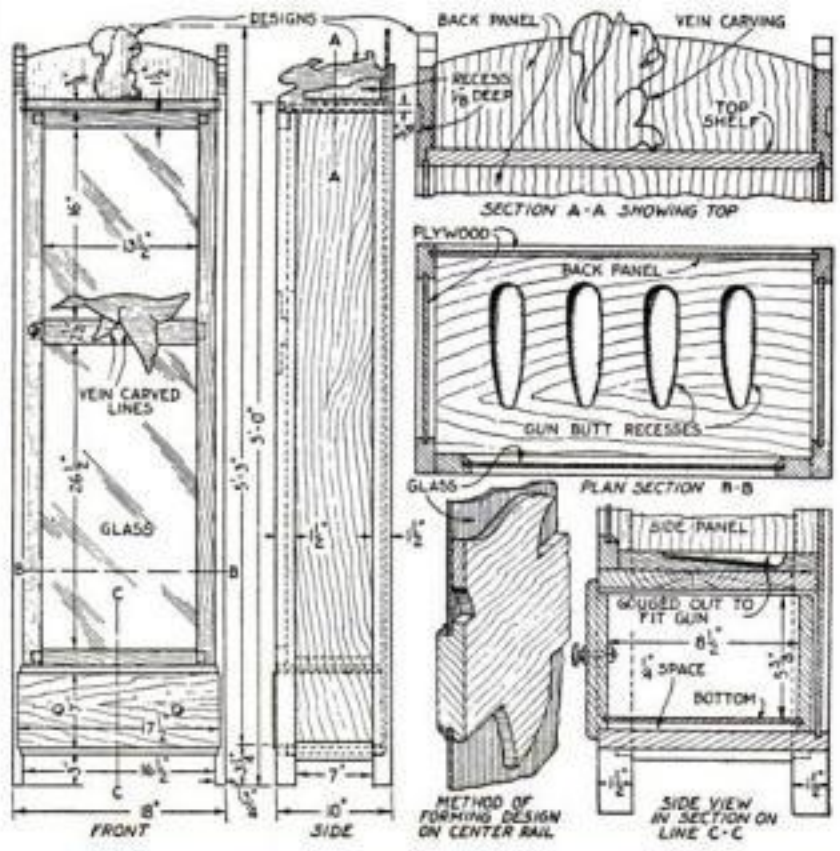
Manual Arts Instructor, Batavia (Ill.) High School

HUNTERS invariably take great pride in their firearms and like to display them to their friends. This can be done most conveniently if a gun cabinet is constructed such as the one illustrated.

While this cabinet requires careful work to build neatly, it is so ornamental and serviceable when completed that no hunter should begrudge the time necessary or the relatively small cost for materials. The experienced woodworker will find the drawings self-explanatory, but the following list of suggested operations may be helpful to the beginner:

1. Prepare the side ornaments, sawing the outline of the rabbits, carving the recesses, cutting the mortises as shown, and planning for the side panels and the back panel.
2. Make two bottom side rails and plow one edge of each for panels.
3. Make four side stiles with tenons at the top end to enter the mortises in the side ornaments and mortises in the inner edges near the bottom to receive the tenons of the bottom side rails. Plow the pieces for the side and back panels.
4. Assemble the sides.
5. Plow the side units for the top and bottom shelves.
6. Cut the back panel

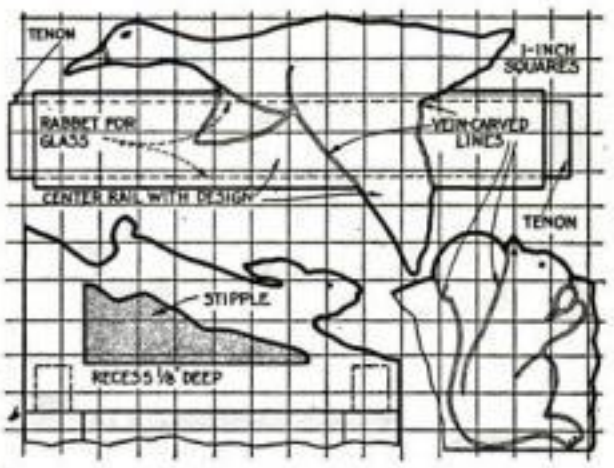
(Continued on page 113)



Front and side views of the cabinet with the dimensions followed by Mr. Ready, and explanatory details drawn to a larger scale.

Making a Gun Cabinet

(Continued from page 112)



By first drawing a series of 1-in. squares, you can easily enlarge these parts to full size.

and carve the rabbit design as shown above.

7. Assemble the case, taking care that it is perfectly square and true.

8. Make door frame, as shown, with the bottom, middle, and top rails mortised into the side rails. The center rail is made of a solid piece ¾ by 8 by 15 in. Half the thickness of all of this piece, except that which forms the equivalent of a 2 in. wide rail, is cut away with the dado cutter or by hand; then the outline of the duck is sawed and carved as indicated.

9. Construct the drawer as indicated.

10. Make gun-butt holder as shown and gouge it out to fit the gun butts.

11. Insert the glass. The molding used is common screen molding ripped through the center.

12. Finish as desired. If made of oak, one coat of old English stain and two coats of flat varnish will give an attractive and durable finish.

The Materials Needed

No. Pcs.	T.	W.	L.	Parts
4	¾	1½	60	Side stiles
3	¾	10	17¼	Shelves (dadoed ⅜ in. into sides)
2	¾	1½	9	Bottom side rails (tenoned 1 in. into side stiles)
2	¾	5¼	10	Side ornaments
2	¾	1½	48	Door stiles
2	¾	1½	15	Top and bottom door rails (tenoned ¾ in.)
1	¾	8	15	Center rail (tenoned ¾ in.)
1	¾	7	17½	Drawer front
2	½	6	8	Drawer sides
1	½	6	15½	Drawer back
1	¼	8½	16	Three-ply drawer bottom
2	¼	7½	55½	Three-ply side panels
1	¼	17	63	Three-ply back panel
1	¾	8½	16½	Gun-butt holder

All dimensions are given in inches.

Knotty Lumber for Boxes

THAT knotty lumber will make a box with short, thick sides more resistant to rough handling than clear lumber, has been learned through experiments at the Forest Products Laboratory of the U. S. Forest Service. The size of any one knot in a board used for this purpose should not exceed one third the width of the board, and the aggregate diameter of all the knots within a length equal to the width of a board should not exceed the diameter of the largest knot allowable. Added to the other advantages of using knotty lumber in boxes is the lower cost of such lumber as compared to clear lumber.

Tiny Trellis Built for Flower Pot

By W. A. DEVETTE

THE trellis illustrated was designed for plants which ordinarily are allowed to droop over the edge of the pot or are placed in hanging baskets. The delicate framework with its graceful curved top makes it possible to train the plant to grow upwards and gives a better appearance when the pot is placed on a window sill or anywhere below the eye level.

The entire trellis can be made from ¼-in. wood, preferably poplar. All the parts are ¼ in. square with the exception of the seven top members, which are cut from pieces ¼ by 1 by 6 in. and are spaced ½ in. apart. The four uprights, which are 9½ in. long, are placed in pairs 4½ in. apart.

The two long crosspieces are 15 in.; they are spaced 3 in. apart and the lower one is placed 3¼ in. from the bottom of the uprights. The two supports for the curved top members are 5 in. long; the four braces are 2½ in. The twenty-three pickets, which are spaced ⅜ in. apart—eight at each end and seven on the "gate"—are cut as follows: three 4¾ in. long, four 5 1/16 in., four 5⅜ in., four 5 11/16 in., two 6 in., two 6 5/16 in., two 6⅝ in., and two 6 15/16 in.

The trellis may be painted or finished with white brushing lacquer.

Flower-pot trellis designed for climbing plants, and a detail showing shape of the arched top.

This article represents in condensed form an entry which won third prize in the elementary woodworking division of a national contest for teachers of shopwork conducted by the Educational Department of POPULAR SCIENCE MONTHLY. Mr. DeVette teaches in the Wilson Junior High School, Erie, Pa.

Twenty-One Tools Made from Outworn Files

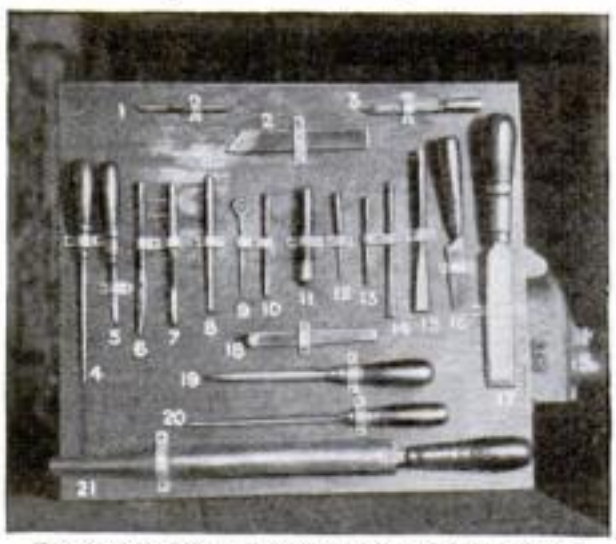
By R. M. KOCH

SOME mechanics regard a discarded file as useless junk, yet old files often can be revamped into useful tools with but little grinding or forging.

Round files may be made into pin and center punches, scribers, prick punches, reamers, and chisels. The file teeth on the grip portion of the tools, when smoothed slightly on the grinding wheel, give the effect of a knurled finish and aid one in holding the tool.

Square and triangular files make glass drills, diamond-point chisels, bearing scrapers, small lathe threading and boring tools, and square-hole broaches. Half-rounds are chiefly used as bearing scrapers; the teeth are ground off the entire length, the inside slightly hollow ground, and the edges honed with an oilstone to a smooth, sharp-cutting surface.

Lathe tools made from flat files give excellent service, especially in threading and cutting-off operations, for they permit working in close corners. Wood chisels of all sizes can be made from flat mill files; and when the temper is drawn slightly, they hold up well in actual use. Considerable grinding is required, however, if it is desired to taper the blade very much, but this is not absolutely necessary, although it improves the appearance of the tool a good deal.



Discarded files provided the steel for these chisels, punches, scrapers, and other tools.

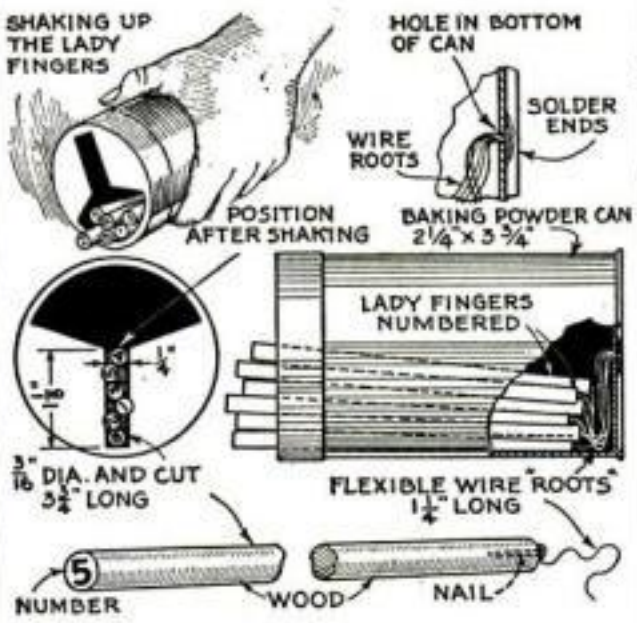
Auger bit files can be made into small screw drivers for radio and electrical apparatus. Cut the file in half, put a small handle on each piece, grind the blades smooth, then draw the temper to a light blue to avoid breaking.

The accompanying illustration shows some tools made from files at odd times with the aid of a grinding wheel only. The tools and the kind of file used in making each of them are as follows:

1. Glass drill made from 8-in. triangular saw file.
2. Lathe cutting-off tool, 12-in. flat mill file.

(Continued on page 115)

A Shake-and-Guess Game for Children



End and side views of the game and details showing how the "lady fingers" are fastened.

"LADY FINGERS" is an entertaining guessing game for children. It also will serve as a novel substitute for a dice shaker or a spinner in other games of chance.

A baking powder can and six round sticks of wood 3/16 in. in diameter and 3¾ in. long are required. The fan-shaped hole in the center can be cut over a block of wood with a small chisel. The wire "roots" that hold the fingers can be made from single strands of picture wire or even fine copper wire. They are fastened to the fingers with small nails; and the loose ends are twisted together, pushed through a hole in the bottom of the can, and soldered to the tin as shown.

The one whose turn it is to play holds the can with the cover down and shakes it around. Then he calls out any number from one to six and brings the can to the horizontal position, with the slot at the bottom, as indicated, so that the fingers fall into the slot. If the called figure rests on top, he is considered a good guesser; if it comes next to the top space, he is allowed another chance; if his number is at the bottom, he is a very poor guesser and is dropped from the game.—DONALD W. CLARK.

Tools from Outworn Files

(Continued from page 114)

3. Sheet metal reamer, 14-in. square bastard file.
4. Leather belt punch, 8-in. round bastard file.
5. Small screw driver, auger bit file.
6. Oil groove gouge, 10-in. round file.
7. Diamond-point chisel, 12-in. square file.
8. Drift punch, 14-in. round file.
9. Pocket scriber, 4-in. round file.
10. Prick punch, 8-in. round file.
11. Heavy center punch, 14-in. round file.
12. 3/8-in. pin punch, 10-in. round file.
13. 1/4-in. pin punch, 12-in. round file.
14. 3/8-in. flat chisel, 12-in. round file.
15. 5/8-in. flat chisel, 14-in. round file.
16. Belt knife and gasket cutter, 6-in. knife section file.
17. 1-in. wood chisel, 14-in. flat mill file.
18. Tinner's scraper, 8-in. flat mill file.
19. Bearing scraper, 6-in. half-round file.
20. Bearing scraper, 10-in. triangular mill file.
21. Bearing scraper, 14-in. half-round file.

Keep the file cool when grinding to avoid ruining the temper.

To cut off a portion of a file, grind a groove completely around it at the desired point, clamp it in a vise, and strike the projecting end sharply with a hammer.

To anneal a file, heat it to a cherry red and keep it covered with lime until cool.

Touching up the handles and grips of your tools with paint improves them.

The bending of star shapes or other intricate forms can be done accurately around nails driven into a board.

Wizardry in Wire Puzzles

How to Develop Original Combinations to Mystify Your Friends—Two Simple Principles Give the Key

By ARTHUR L. SMITH

YOU can devise many fascinating wire puzzles if you are familiar with the two simple principles presented here. Bus bar or copper antenna wire may be used. All joints are best if soldered neatly, but the work itself is not difficult.

In Fig. 1 we have two rings hinged together, *A* and *B*. On one of them hangs another ring *C*, and over this is the somewhat smaller ring *D*. The solution is so simple that it can scarcely be called a puzzle. *A* and *B* are folded together as in Fig. 2. Ring *C* with *D* will slide down to the joint, permitting *D* to be lifted off as shown.

If for *A* we substitute a star as in Fig. 3, the solution is not so apparent, since *D* must be worked around through the points of the star. Ring *B* in this case should not be too large; its circumference should cut the points of the star in half. *D* should be just large enough to slip over the points. For *C* in Fig. 1 we may substitute a triangle, star, or other form.

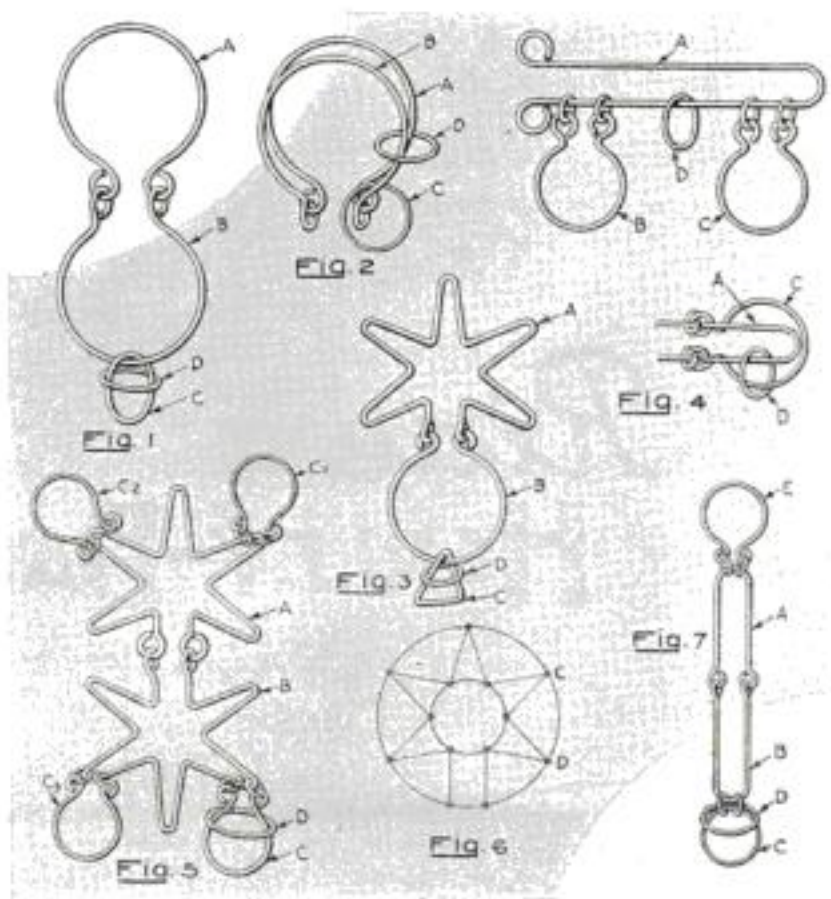
Another principle is illustrated in Fig. 4. On the U-shaped wire (in the upper of the two diagrams) are hung rings *B* and *C*. Between them is the smaller ring *D*, which may be removed as shown in the lower diagram.

By combining this principle with that of Fig. 1, we can make a confusing puzzle. For *A* and *B*, Fig. 1, we substitute two stars as in Fig. 5. On the points of these are hung the four rings *C*, C^1, C^2, and C^3, two on each star. On one of these, *C*, for instance, is placed the ring *D*. To remove it, the *C* ring holding it is worked around to the joint. The stars are folded together, and *D* may be removed by working it around through the points and the other *C* rings on the principle shown in Fig. 4. Another *D* ring may be put over either C^2 or C^3, and it is possible to remove both *D*'s.

To make this puzzle it is best to lay out a star on a board as in Fig. 6. Two circles are described from the same center, one within the other. The angular degree and the length of the points will depend upon the difference in their diameters. For a six-pointed star the radius of the circle will give the distance between the points.

Nails are driven into the board at the points of all angles as shown. The heads must be cut off so that the nails do not project more than ½ in. above the surface. The wire then may be bent accurately around the nails.

Figure 7 shows another variation of these two principles. *A* and *B* of Fig. 1 are elongated to U shapes so that *D* may slip over them. On the ends of these must be hung devices to prevent the removal of *D*. The illustration shows a ring *C*, over which is placed *D*. At the other end is another ring *E*, attached as shown. To remove *D*, the U's are folded and ring *C* is moved around to the joint, which permits *D* to be brought around to the bend of U and worked through *E* on the principle of Fig. 4. Ring *C* may be attached in the same manner as *E*, if desired.



A few of the many puzzles which can be made by utilizing the two solutions shown in Fig. 2 and in the lower view of Fig. 4.

This Model Flies Up

(Continued from page 81)

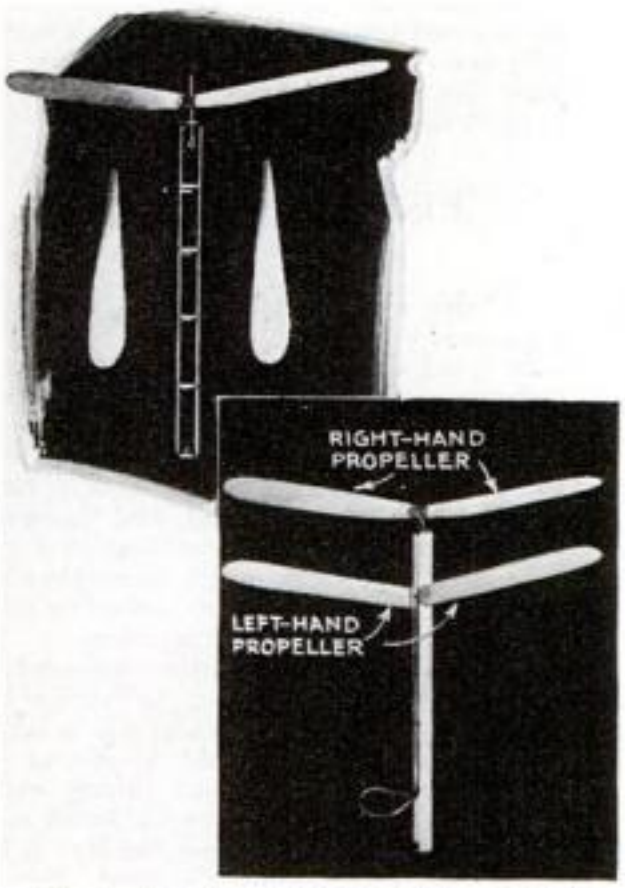


Fig. 3. How to mount the revolving propeller (upper view); the completed model (lower).

the other blade to the opposite side. Be sure that these blades in both cases are arranged so that the rounded side of the camber will be up. It is suggested that you fasten the blades 1¾ in. down from the body so that they will be braced by the small body crosspieces.

These propellers should be as light and feathery as it is possible to make them. They can be brought down in weight and thickness by a generous use of coarse and fine grades of sandpaper. Use No. 2 at first and finish off with No. 0000. You will find it necessary to install the propeller shaft in the revolving propeller by slipping it through the underside of the top piece, placing two washers and the propeller on it, and then fastening it to the propeller.

A long shaft will be found helpful in counteracting any wobbling effect, in which case No. 6 (.016 in.) music wire is a suitable size.

Two strands of 1/32 by 1/8 in. flat rubber are satisfactory for this machine. Unhook the S-hook and wind the motor as for an airplane model; then replace the S-hook with pliers or tweezers.

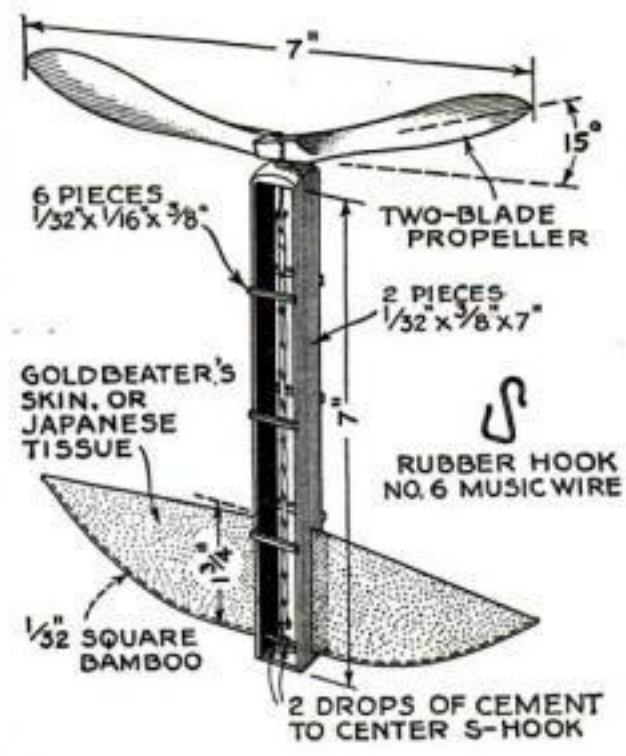


Fig. 4. Design for a Penaud model like that given the Wright brothers by their father.

Novel Saw Rack Saves Waste Motions

A rack which holds saws in a position to be picked up without a moment's loss of time.

AS AN improvement over hanging up my saws on nails, I built the rack illustrated, which allows the saws to be grasped instantly in the proper position for use. The rack can be made of 1 by 2 by 12 in. or heavier pieces spaced 3/16 in. apart and screwed to a 2 by 4 of the required length.—GEORGE W. ROYER.

When Doors Need Paint

(Continued from page 90)

First paint *A*, next *B*, then *C*, and so on.

with turpentine, but a little good floor or spar varnish should be added to knit the new paint to the old varnish firmly and to avoid cracking later. A good proportion of varnish to turpentine is about one third varnish and two thirds turpentine for this coat, although as little as one fourth varnish will serve the purpose.

For applying the paint you should have a flat brush of good quality with long bristles — one about 2 or 2½ in. wide. You will need also a round or flat 1-in. brush if there are lights of glass in the door.

It is necessary to remove the door from its hinges to paint the bottom and the top edges. It is very important to paint these edges to prevent warping. After painting them, place the door on its hinges again and paint the parts in the order shown above.

The door knob and escutcheon plates should be removed before painting. If the hinges are solid brass it is usual to keep them free from paint, but if they are plated it is customary to paint them.

The Materials Needed for Two Coats

a. Ready-mixed outside oil paint, 1 pt., or
b. White lead paint requiring:
1 pt. boiled linseed oil
1 pt. turpentine
5 lbs. white lead, regular grind
1 lb. tinting color to suit

Note: The formula for white lead paint is based on the use of a 5-lb. can and will make a little more than 1 qt. of paint, or enough for two doors.

Fishermen's Knots

(Continued from page 102)

as reliable as the slightly more complicated compound loop knot.

In tying the compound loop, first form an ordinary slip or running knot (Fig. 1). Then loop the free end about, passing it over the two portions of the large loop and under the remaining parts of the line as shown in Fig. 2. Finally draw the knot tight, and you have a loop that will not slip or break easily. For the sake of clarity, a cord much larger than anything you are likely to encounter in fishing was used in making the illustrations.

Perhaps you wonder why the compound knot is recommended rather than the familiar bowline, which is easier to tie and which, at first glance, looks as if it would do just as well. After much experimenting, fishing experts have found that the bowline will break sooner than the compound because the line is bent more sharply in forming the knot. For that reason, the latter knot has been adopted as standard on manufactured tackle, and has proved its superiority during years of use.

If you do even the simplest fishing, you will encounter the difficulty of joining two pieces of gut leader together. When you use an ordinary knot, the chances are that the splice will part just when it should hold. So it will repay you to tie the twist knot (Fig. 6), considered by many anglers as the best for such purposes.

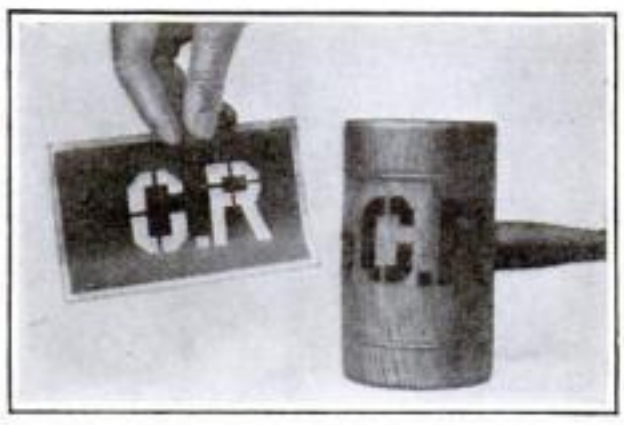
In tying it, first twist the two ends about each other, giving each two turns as shown in Fig. 4. Then pass the ends through the central opening between the twisted lines in opposite directions (Fig. 5) and pull the knot taut.

To attach the fishing line to the loop of a snell or leader in such a way that you can untie it quickly, there is nothing better than the helm knot or tiller hitch. It is easy to tie, as shown in Fig. 7.

Other knots which the fisherman can use include the single and double buffer, the common leader, and the reef or square knot. However, the three knots illustrated will be found superior in most instances.

These knots are by no means confined to fishing activities. They are useful for joining all kinds of ropes and lines. Knowledge of how to use knots has saved many a life.

Old Photographic Films Make Good Stencils



Stencil cut from an old negative with a razor blade. It bends without cracking.

WHEN regular stencil paper is not available, an old photographic film is a practical material for making any simple stencil which does not require too careful and elaborate design and craftsmanship. Such a stencil is easy to keep clean.—F. W. BENTLEY, JR.

Reproducing an Old Chair

(Continued from page 104)

List of Materials

Parts	No.	Dia.	Length
Legs—back	2	1¾	38½
front	2	1⅝	16
Rounds—front	2	1	18½
side	4	1	12½
back	1	1	12½
seat	1	¾	12½
seat	1	¾	18½
seat	2	¾	13
Slats, bowed	4	⅝ by 2½ by 13 long.	

Fiber or rush sufficient for one seat.

The stock is maple. All dimensions are in inches.

the middle. These are usually worked out by hand. Only one round is to be placed under the seat and between the back posts; this is on the same level as the bottom one on the front side. As a matter of fact, I could find no sign of a rear round on the old chair, but for additional strength it seems advisable to include one.

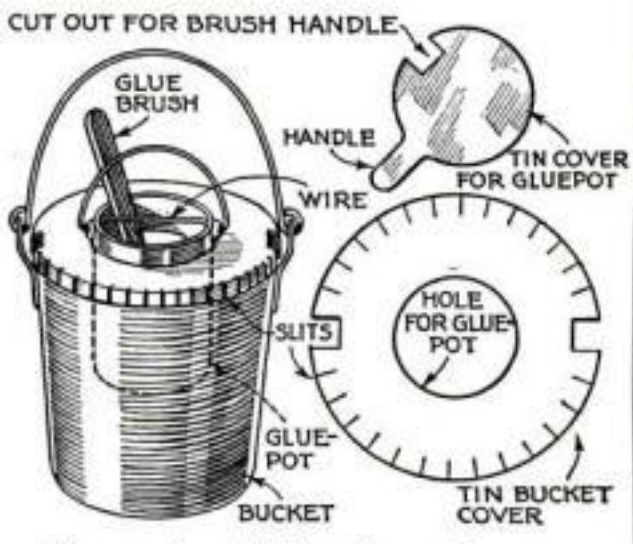
The slats are only ⅝ in. thick. As they are bowed slightly, each piece can be steamed or soaked in boiling water and then clamped to a form. Another way is to shape each slat from a piece of stock 1 in. thick with the aid of a spokeshave.

At the present time many old chairs of this type are being refinished in modern ways. Some are even painted jet black with touches of gilt or bronze paint; others are given a dark brown or chocolate color. For an antique maple finish, a very light walnut stain may be used and wiped or sandpapered off in places to give a high-lighted effect.

If it is not possible to obtain rush or fiber locally, send a self-addressed stamped envelope to the Information Department of POPULAR SCIENCE MONTHLY for the names of dealers.

Homemade Gluepot Keeps Hot a Long Time

WHEN a large quantity of hot glue is to be used and a gluepot of suitable capacity is not available, an excellent and inexpensive substitute can be made as shown from a 6- or 8-qt. galvanized pail, a 5-lb. syrup bucket or similar container, and a sheet of heavy tin.



Glue remains fluid in this pot for considerable time when once the water is hot.

The large quantity of water which this gluepot holds is an advantage because with one heating on the kitchen range or gas stove the glue will remain in a fluid state for a considerable time.

Do not omit the cover for the small bucket because keeping the glue covered when not actually being used will prevent a "skin" from forming.—R. C. STANLEY.

Reseating a Chair with Cane

Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *furniture*. (August, 1929, POPULAR SCIENCE MONTHLY.)

What materials and tools are necessary to reseat a chair with cane webbing?

CANE webbing, either open or close woven; splines, preferably of reed, if the groove in the chair is curved; glue, and a sponge or cloth and water.

Machine-woven cane webbing may be obtained in either open or close weave, in various widths by the running foot, and in several sizes of canes and meshes. Open-woven cane webbing of "fine-fine" cane is the kind and size generally used for reseating chairs.

Splines are narrow wedge-shaped lengths of reed or wood. They are forced into grooves with the webbing, and their function is to hold the cane securely in place. These are sold in lengths of about 10 ft. each and in three sizes. The medium size should be used with fine-fine cane webbing.

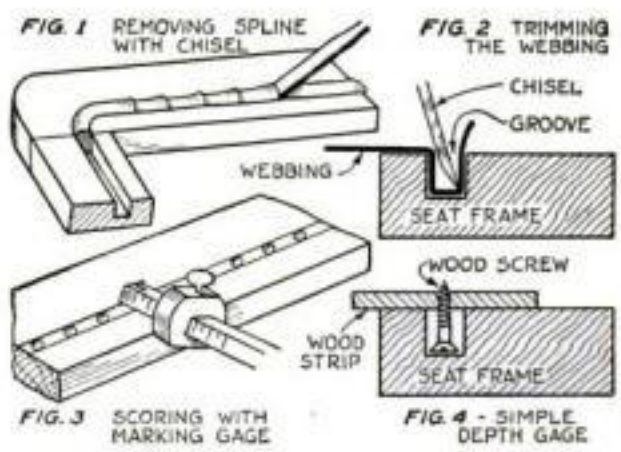
The tools required are a mallet or hammer; 1/8-, 1/4-, and 3/4-in. chisels; wooden wedges (to be made); a pair of heavy scissors or tinner's snips, and a jackknife.

How is the seat frame prepared for caning?

1. Cut off the webbing with a knife next to the spline. 2. Remove the spline with chisel and mallet (see Fig. 1). 3. Clean out the cane ends and glue with a chisel. 4. Wash the frame with soap and water. Scrape the inner surface of the frame if necessary.

What is necessary to prepare the materials for use?

1. Make about five wedges of 1/4-in. hardwood in several widths varying from 1 to 2 in. Taper them at one end to 1/8 in. in thickness.



Figs. 1 to 4. Steps in removing a spline, cutting the cane, and marking and testing a groove.

2. Lay the webbing over the frame and with scissors or snips cut the piece so that it extends over the groove about 1 in. all around.

3. Soak spline and webbing in water until thoroughly pliable. (Continued on page 121)

Reseating a Chair

(Continued from page 120)

Warm water will speed the softening process.

4. Fit the spline loosely in the groove, if the groove is a curved one, and cut it to length. Make the joint at the back of the frame. If the corners are angular, cut miters on the splines.

What is the method of caning the seat?

1. Place the webbing over the seat frame, allowing the parallel strands of cane to run parallel with the front edge of the frame. Drive the webbing into the front groove with a wedge. Let the wedge remain.
2. Drive the webbing in with a wedge in the opposite groove.

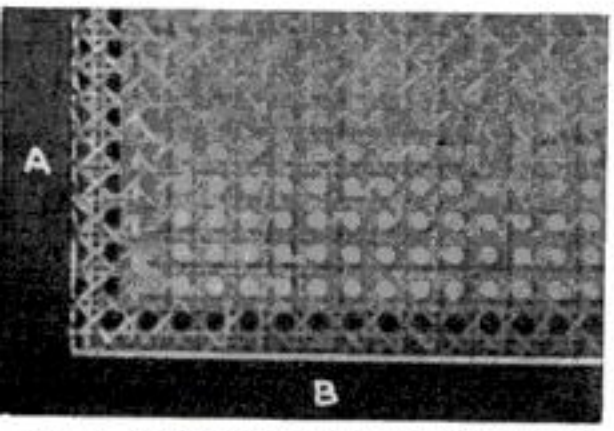


Fig. 5. Corner of a seat frame which shows webbing trimmed at *A* and spline inserted at *B*.

3. Repeat the process with two more wedges at the other two grooves.
4. With another wedge force the webbing in the groove entirely around the frame. Remove the fixed wedges as the work progresses.
5. Cut off all ends of the webbing with a chisel in the bottom of the groove at the outer corner (see Fig. 2).
6. Run glue into the groove and distribute it over the cane and sides of the groove.
7. Drive the spline in with a mallet, protecting it with a block of wood. Be careful that the curved edge of the spline is not driven below the surface of the frame (Fig. 5).

What finishing is necessary?

1. Sponge off all excess glue.
2. When the webbing is nearly dry, the hair-like projections, if any, may be removed by passing the webbing over a gas flame. Be careful not to burn the cane.
3. When the cane webbing is to be left a natural color, it will look better and last longer if it is given a coat of tough, elastic varnish.

When hand-woven seats are to be replaced with machine webbing, what are the steps to follow?

1. Cut off the old seat with a knife, clean out all ends of cane from the holes, and wash the frame with soap and water.
2. File the spur of a marking gage to a knife edge. Set the spur to coincide with the inner edges of the holes, and gage entirely around the seat frame. Repeat the process several times so as to make the scoring reasonably deep. Continue the scoring in inaccessible places with a knife.
3. Increase the gage setting 3/16 in. and again score entirely around the frame (Fig. 3).
4. Cut the groove 1/4 in. deep with a chisel in the same manner as spline is removed (Fig. 1). It is advisable to make a simple depth gage (Fig. 4). A router plane may be used to finish the cut if available. Clean out the groove thoroughly. Round the corners lightly with a chisel or sandpaper.
5. Proceed with the reseating as previously explained.—L. D. Perry.

Home Workshop Chemistry

(*Continued from page 107*)

1 in. wide. By crosslines ¼ in. or more apart, divide the strip in fifty oblong fields. Also obtain a cake of cobalt blue and one of rose color—both water colors—a glass of water, and a fine camel's-hair brush.

Borrow a calibrated hygrometer, if possible, and hang it up in the bathroom on a particularly dry day. Place the impregnated paper on a board set across the bathtub or in some other convenient position.

If the air in the room is so dry that the hygrometer shows practically no moisture, paint the first field on the strip of drawing paper with cobalt blue so that the tint corresponds exactly with the color of the treated paper. Then turn on the hot water, and as the bathtub fills, watch the hygrometer carefully. When it indicates two degrees of moisture, quickly paint the second field on the paper tape the same color which your impregnated paper shows. Continue in this way as the humidity increases at two-degree intervals until you have completed the series of fifty fields, each representing an increase of two percent in humidity.

WATER colors do not look exactly the same when dry as when they are first applied, but the difference is not enough to cause any serious error; and, indeed, you can allow for the change if you do a little preliminary experimenting.

After the paper ribbon with the painted scale of tints is dry, mark each field with the number of degrees of humidity which the color represents as indicated by the hygrometer. This calibrated strip enables you to determine with fair accuracy the percentage of moisture in the atmosphere by comparing the tint of the impregnated paper with the color scale.

The impregnated filter paper will retain its sensibility to moisture and hence its value as an indicator indefinitely, provided it is kept clean and free from dust. A simple, convenient, and effective way of mounting the paper is to suspend a strip of it in a vertically mounted glass tube, open at the bottom and covered at the top with a loose layer of absorbent cotton.

If the impregnated filter paper is to serve as a calibrated hygrometer for scientific purposes, it is better to mount a square of it behind glass in a small framelike box, which should be open at the bottom and sides to admit the air and at the same time protect the contents from dust. In the center of the paper a small window should be cut out, corresponding in size to the oblong fields of color on the calibrated color scale. This strip of paper should be so mounted behind the filter paper that it can be slid up or down until the color of the field of the scale matches exactly the color of the paper. The figures on the calibrated strip will indicate the degree of moisture.—ERNEST WELLECK.

Painting in Damp Weather

AMATEUR house painters are told repeatedly and emphatically never to attempt to paint in damp weather. Occasionally, however, it is necessary to take a chance for some compelling reason, as when any delay would interfere with other essential work. In such cases it is wise to follow the example of professional painters and apply the paint with exceptional vigor, brushing it out thoroughly in a thin, uniform film.

Prolonged and painstaking brushing will counteract some of the adverse results which come from painting in damp, chilly weather and will lessen the likelihood that the paint will wrinkle. Since oil thickens in the cold, it is permissible to thin the paint slightly with turpentine, even the last coat, which ordinarily should carry very little turpentine. Add only sufficient to allow the paint to be brushed out thin; too much will reduce the gloss.

A definite program for getting ahead financially will be found on page four of this issue.

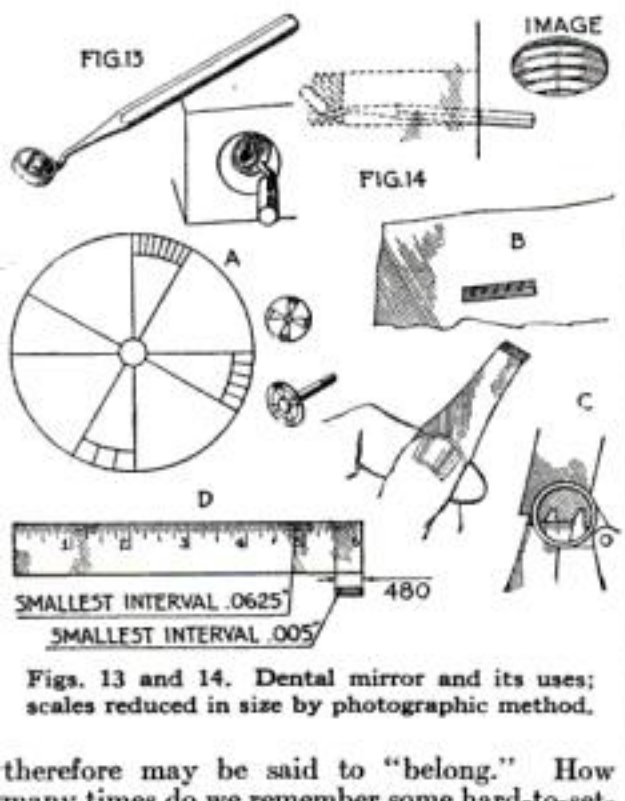
Tools That Help You See

(*Continued from page 98*)

the work by way of the first mirror, and a reading glass may be used to magnify the image in the first mirror, as in the diagram at *B*. In this way the mechanic can keep a magnified image of the recess or bore before him without straining or moving in any way from his natural position.

One of the handiest tools in the shop is a dental mirror for examining tapped, reamed, or recessed holes over ⅝ in. in diameter and small bores and recesses of every kind, as suggested by Fig. 13 below. With its long handle, it enables you to get down into deep places and reveal things you could never know otherwise. Because of its handiness the dental mirror makes an excellent inspection tool for many purposes. When necessary it may be used in combination with a small electric lamp.

There remains our friend the camera, which, although not exactly the simplest kind of instrument, yet is owned by everybody and



Figs. 13 and 14. Dental mirror and its uses; scales reduced in size by photographic method.

therefore may be said to "belong." How many times do we remember some hard-to-set-up job on the lathe, or some other odd "rigging" that we took hours to figure out, only to find when we had to repeat it half a year later that we had it to figure out all over again! A "shot" with an ordinary pocket kodak, costing all told ten cents and ten minutes time, will preserve the entire set-up with every clamp, bolt, block, washer, balance weight, and other accessories and their exact arrangement.

The writer for years regularly used such photographic records for all difficult or "touchy" set-ups on automatic screw machines. If a photograph such as that reproduced at the bottom of page 96 saves only half an hour in getting a machine running, it will more than have paid for itself.

Finally, there is the reducing ability of the photographic camera. This is especially useful for the experimenter. Fig. 14 at *A* shows a temporary but accurate scale required on a shopmade instrument; it was produced from a large-scale drawing by the camera to a degree of fineness and accuracy that would be utterly out of the question by hand.

At *B* is a similar reduction of a regular length-measuring scale. In conjunction with a 10-power magnifying glass, such a scale may be used to read off lengths of .005 in. and to estimate .002 in. Contour distances such as those at *C*, the width of graduations, scratches, prick marks, and similar things that are otherwise difficult to measure, can be easily ascertained in this simple manner.

A good way is to reduce a regulation 1/16-in. scale to one in which each 1/16-in. division equals .005 in. as shown at *D*, which means that the picture of a scale 6 in. long will have a length of .480 in.

Ornaments for Your Home

(Continued from page 80)

furniture, for which the majority of transfer designs are unsuited. Those which are made of wood composition will take stain practically the same as any wood surface. They may be stained like the flat surfaces, or very pleasing two-tone effects may be produced by wiping the stain from the carvings before it has commenced to set.

In some cases it may be desirable to thin the stain before applying it to the carvings and afterwards to wipe it off, too, in order to obtain just the desired effect. As a rule, however, too great a contrast between the two tones should be avoided. Often a delicately beautiful effect may be gained by using sandpaper or steel wool to produce the high lights after the stain is dry, instead of wiping it off when wet.

In stain finishing no preparation of the surface is necessary; in fact, the stain must be applied directly to the surface so that it will have an opportunity to penetrate. The stain is followed by a thin coat of shellac, which seals it and keeps it from bleeding through the finishing coats of varnish.

Where lacquer, oil paint, or enamel is used for the color decoration of carvings, it is a safe practice to apply a preliminary coat of shellac to seal the surface, although that is not necessary with some of the makes of ornamental carvings on the market.

The second type of relief designs—those for wall decorations—may be obtained in the form of panel medallions, borders, friezes, panel moldings, cove cornices, centerpieces, over-fireplace panels, plaques, pendants, pilasters, and rosettes.

Wall relief ornaments are applied on top of the plaster. The heavier cast relief forms are cemented in place with plaster of Paris and glue size, or plaster and lime.

The pressed fiber and lighter composition ornaments are usually applied with wall paper paste or plastic paint. Where wall paper paste is used, it is brushed on to the back of the ornaments (several at a time) and allowed to

Coloring an ornamental carving applied to the otherwise plain door panel of a china closet.

soak in for five minutes or so. Then another coating of paste is applied, and the ornaments are placed on the wall. They should be pressed tightly into contact with the surface, which is best accomplished with a flat wooden paddle or other instrument, pushed hard against the low places of the ornament.

Care must be taken not to flatten out the raised parts of the design while it is wet with the paste. Any wrinkles or buckles in the flat part of the relief may be smoothed out with a paddle or a putty knife.

When ornaments are applied over bare plaster, the wall first should be sized to prevent the paste from soaking in.

Plastic paint, if available, affords the best

Carved design composed of three separate pieces. When a unit of the desired shape cannot be had, it is often possible to combine two or more ornaments. In finishing the carving, stain is applied freely, then partly wiped off.

method of applying the pressed fiber ornaments. The same procedure is followed as with paste, except that the plastic paint is pressed into the crevices at the back of the relief form until they are a little more than full. This method gives a solid surface when dry and insures a firm, smooth job.

When used in rooms that are done throughout in plastic paint decoration, the ornamental forms are simply pressed into the plastic paint, which holds them securely in place.

All of the usual forms of wall and ceiling color treatment may be used over these ornaments. Being more or less porous or absorbent, they ordinarily require the use of a size or priming coat to seal the surface just as do bare plaster walls. Afterwards they may be brush coated with wall paint, "Tiffany" or sponge stippled, two-toned glazed, or dusted.

The use of the pressed fiber type of ornament offers a number of desirable mechanical advantages over solid plaster, which, in any case, the amateur cannot easily apply. They do not crack or check, and, being somewhat flexible, they conform to any irregularities of construction. It is not necessary to saw and trim them to an exact fit; imperfect joints and crevices may be filled with plastic paint or plaster of Paris and paint. In fact, when fiber moldings are applied with paste, it is preferable not to butt them tightly together, but to allow about ⅛ in. between lengths for expansion, the gap to be filled with any suitable composition when the moisture from the paste has dried out.

The possibilities of relief ornamentation are almost unlimited. Ceiling centerpieces may be used in sets with larger and smaller ones of the same design in adjoining large and small rooms. Another method sometimes employed is to repeat detached motifs at intervals and tie them together with lengths of a suitable border design. Relief forms in period motifs also are obtainable for use in period interiors.

Hints on Sharpening an Ax

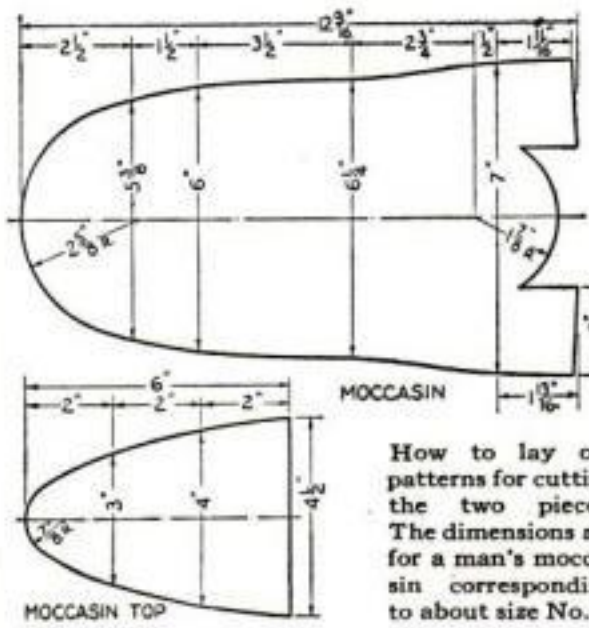
IN SHARPENING an ax for chopping, give the blade a long bevel and a fine, sharp edge. For splitting, on the other hand, the blade should not be ground so far back because its purpose is to wedge the wood apart quickly and tear the fibers, not cut out large chips. If you do considerable splitting and chopping, it is well to use a double-bladed or double-bitted ax with one splitting and one chopping edge.—ARTHUR KEIL.

Pattern for Cutting Strong Moccasins

Two-piece moccasins which require a minimum of sewing, yet are strong and comfortable.

A STRONG, serviceable moccasin can be made of two pieces of leather cut as shown in the drawing below. The leather used should be fairly flexible, but not too thin.

The seams are made by butting the edges together and sewing through them with heavy waxed linen thread so that the thread is concealed wherever it crosses the joint. The rear vertical seam should be sewn first; then the rear horizontal seam should be sewn from the center each way, because a certain amount of pucker will be necessary in order to make a smooth joint. Similarly, the top piece should be fastened at the center of the toe and sewn both ways.

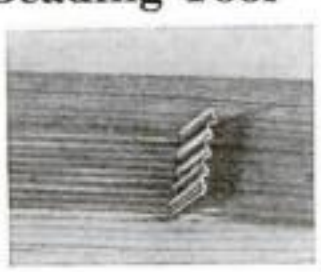


How to lay out patterns for cutting the two pieces. The dimensions are for a man's moccasin corresponding to about size No. 9.

The dimensions given will make a moccasin of about men's size No. 9. By cutting down the center of the top piece for 2 in. and inserting eyelets, a lacing can be used which will adjust the moccasin to larger or smaller feet. For foot sizes considerably smaller or larger than size No. 9, the pattern should be adjusted from a standard foot chart.—ROBERT T. POUND.

Emergency Beading Tool

IN AN emergency a sawtooth corrugated fastener is a good tool for scratching ornamental beads in wood. A wooden strip may be used as a guide.—RAYMOND WAILES.



Corrugated fastener used to cut beads. It is advisable to hold it with pliers.

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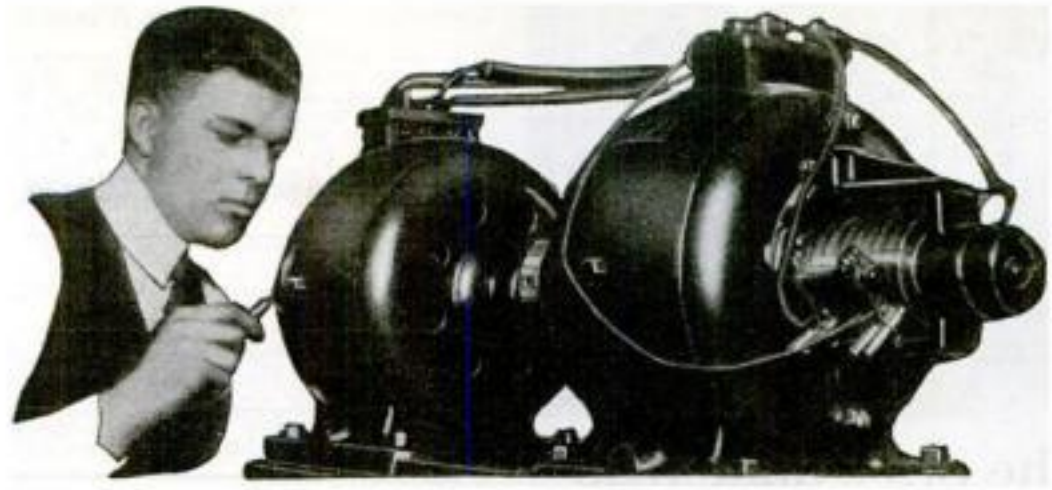

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Dollars Your Car Can Save You

(Continued from page 84)

so what I spend at the club ought to be charged against the car—and, believe me, it's plenty! That car doesn't do anything else but take us to places where we can spend money!"

"H'm," grunted Joe. "You seem to make out a case. What have you got to say, Ted, for your side of the argument?"

"Well," Ted began, "I drive about as many miles as Mac does, so I guess the four-hundred-and-eighty-dollar figure fits me, too, but the car saves money in lots of ways."

"As for instance?" questioned Joe, jiggling his pencil.

"On vacations, for one thing," Ted explained. "If you want to put down some figures, you can start with exactly fifty-six dollars and eighty cents railroad fare we saved last summer. That's what the tickets for the wife, the two kids, and myself would have cost on my vacation. Then you can put down at least four dollars more that we saved on expressage by carrying our baggage in the car. Also, because we had the car and didn't have to hang around the hotel all the time, we were satisfied with a cheaper hotel farther from the beach. That saved at least twenty dollars on the hotel bill. And we found a beach where we could conveniently get into our bathing suits in the car. Every time we did it we saved just one-fifty in bath house fees. Figure all that up for a two weeks' vacation! This year we're going motor camping for our vacation and we'll save still more."

"THAT'S nearly a fifth of your car expense already offset by saving," Joe commented. "How do you account for the rest?"

"It's kind of hard to give definite figures," Ted said slowly. "It's principally in getting our fun out of the car instead of spending money on more expensive amusements. Nearly every clear Sunday we go off on a picnic in the car. That doesn't cost us anything but the food, and the wife says it's cheaper to get up a picnic than to cook Sunday dinner. Then, since we've got the picnic to look forward to on Sunday, we don't bother to go to the movies on Saturday night as we used to before we got the car. The savings that way ought to come to quite a respectable total during the course of a year.

"Before we got the car I used to hang out with a bunch of fellows from the office Saturday afternoons. Usually we went to a matinee, or shot some pool or something, and what with one thing and another I generally spent at least three or four dollars. Now I head for home right after the office closes, have a bite to eat at home, and we go for a ride; or, if the wife is busy, I spend the afternoon washing and polishing the car."

JOE'S pencil was busy for a few minutes. "By Jinks!" he exclaimed. "Looks to me as though you'd come pretty close to justifying the entire car expense."

"If I haven't," Ted grinned, "you can put down a little something for doctor's bills saved. I've noticed that we don't have to call in the doctor quite so often now that we spend more time outdoors."

"Well," observed Joe, "far as I can see, you're both right in this argument. Each one of you is looking at it from a different viewpoint. It only goes to show that a car will help you to spend money if you're inclined that way, or it will help you to save money if you'll let it!"

HAVE you a motor car problem that needs solving? Let Gus and Joe answer it. Write to Mr. Bunn in care of POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Reese—A Man Who Always Does the Impossible

(Continued from page 32)

We discovered it just as you said we would."

"Good work!" exclaimed Dr. Reese. "I knew you'd succeed."

The other had scarcely finished telling how the result had been arrived at when Dr. Reese's telephone rang.

"I called you to say that we've found out how to make diphenylamine." It was the voice of the chief chemist of the other laboratory!

"Both of them found the secret," Dr. Reese told me, "and we did not lose a day on our British contract.

"And that experience proved what I had long maintained—that the time had come for America to declare its chemical independence of Europe.

"To make diphenylamine we had to get into the aniline business ourselves. Now was the time to lay the foundation, at least, for an American aniline and dye industry."

He got the backing he asked for to do precisely that, and as a result of the new markets created for their services there are more American chemists employed in industrial research today than in all the rest of the world put together.

IF HE had never done anything more than that Dr. Reese's name would always stand high in the annals of America. But that is only a small part of his achievement.

Another war victory, for example. High explosives, of which trinitrotoluene (T.N.T.) is the most famous, came to play a greater and increasing part in the war. Here, again, America and the rest of the world were dependent upon Germany. Toluene, the essential substance of T.N.T., is another product of coal tar. The formula in this instance was no secret, but there wasn't enough toluene being produced in America to supply anything like the war demand of the Allies, let alone our own probable requirements should we get into the conflict. Dr. Reese, already deep in the aniline business, knew the whereabouts of every ounce of toluene, knew precisely what facilities existed for its production, knew just what would have to be done and how long it would take to produce more. And it all added up to less than enough.

What was needed was a new way of making toluene. So again Reese called in his chemical right-hand men.

"We ought to be able to build up toluene out of benzene," he told one group. "See what you can do." To the other group he said: "See if you can find a way to break down xylene into toluene."

THE result was a repetition of the former effort. Both laboratories found ways to make toluene. What proved of even greater importance, one of them developed a new substance, xylol, which proved of even greater value than toluol, so that when the United States went into the war we loaded our depth bombs and high explosive shells with trinitroxylol—T.N.X.

Those two war incidents illustrate the method by which scientific research in industry is done. Teamwork, organization, a definite problem stated; perhaps a suggestion as to how it may be solved. That is the method established by Dr. Reese, and now adopted in every great research laboratory. It is a method which demands from the man at the head of the research organization, not only a thorough knowledge of science, but a thorough understanding of its economic relations and the ability to organize and train a staff of scientists and get the most out of them.

"Like a school-teacher setting problems for his classes to solve," I suggested. Dr. Reese, tall, erect, with pince-nez astride his nose, reminded me of more

(Continued on page 131)

Reese—A Man Who Always Does the Impossible

(*Continued from page 130*)

than one of the teachers of my own youth. He smiled at my suggestion.

"Of course," he said; "it's merely an extension of my life work, teaching chemistry, into the field of industry. I've been teaching chemistry ever since I got through going to college myself. I was brought up in an atmosphere of chemicals. I can't remember when I wasn't interested in the subject."

Dr. Reese's father had been a druggist, in the days before the Civil War when the more familiar sign on a drug store front was "Chemist." An uncle was also an apothecary; another uncle and a grandfather were physicians.

"I never lost my interest, even as a boy, in trying to find out what different things were made of," Dr. Reese told me. "I remember picking up a piece of stone in a field near Baltimore, observing that it was composed of several different kinds of stone fused together, and spending a great deal of time and study trying to discover how it got that way."

BORN in Baltimore in 1862, young Reese's early surroundings were those of literary and artistic culture supported by modest wealth. He was not yet twenty-two when he graduated from the University of Virginia, with his enthusiasm for chemistry heightened by the work he did there. Then he went to Germany, to famous Heidelberg, to study more chemistry, and returned with a Ph.D. degree to his home city to become an instructor in chemistry in the young Johns Hopkins University.

"I didn't have any idea at that time of ever doing anything except teach chemistry," Dr. Reese told me. "If I had told anyone that I expected some day to organize chemical laboratories for industrial concerns I would have been laughed at. Science and industry were far apart as the poles, at least so all industrialists and most scientists believed."

So from teaching chemistry at Johns Hopkins he went on teaching chemistry, as professor of that science, at Wake Forest College in North Carolina and the South Carolina Military Academy, until 1896, when he went back to Johns Hopkins and taught chemistry until 1900.

WITH the turn of the century business began to be done on bigger and broader lines than before, business men began to slough off some of their contempt for "college men," university professors began to realize that America is, after all, a business nation, first and last, and that there is nothing incompatible with culture in the effort to improve business.

The New Jersey Zinc Company had a problem to solve—how to make sulphuric acid more economically. Looking for a chemist to solve it, they picked Dr. Reese. He found the way.

It may not mean much to the man in the street to learn that someone has found a new way to make sulphuric acid, but that substance is the most important chemical in all industry, even more important, probably, than alcohol. So although Reese's new process didn't get him any headlines in the newspapers, it made a real sensation in industry. Business heads began to ask the identity of the young man who had found the revolutionary process. When it was disclosed that he was merely a college professor, most of the curious ones just laughed. But Eugene du Pont, then president of E. I. du Pont de Nemours & Company, asked Dr. Reese to come and see him. Perhaps a university-trained chemist could find out some interesting things about explosives. Their meeting was the beginning of the new era in American industrialism.

Dr. Reese proposed that the Du Ponts establish a research (*Continued on page 132*)

Reese—A Man Who Does the Impossible

(Continued from page 131)

laboratory on purely scientific lines, as was done in Germany.

"That was almost the first, if not the first, really scientific industrial research laboratory in America," he told me. "The General Electric Company had begun some research work in a small way about the same time, 1902, but that is the only instance I know of which compares with what I was privileged to inaugurate for the Du Ponts."

One laboratory grew into five. The problems of explosives were solved, and the by-products of the explosive business began to compare in value with the explosives themselves. For the chemical laboratories were finding ways to make the same raw materials which entered into the manufacture of smokeless powder into a thousand other things.

Nitric acid, sulphuric acid, and cellulose are the basic chemicals in the manufacture of modern explosives. Before the European War the laboratories under Dr. Reese's direction had developed ways of using those and a few other substances for the manufacture of artificial leather, artificial ivory, or pyralin; and other products. The war slowed down activities in these fields, but opened up others.

ONE was the development of a method of extracting nitrogen from the air. Chile nitrates had been the world's only large source of fixed nitrogen when the war began. Germany had a process of fixing atmospheric nitrogen; so had Norway, and so, in a still semiexperimental way, had America. Dr. Reese set his chemists to work to study all of these and all other possible methods of fixing nitrogen.

"Almost the commonest of all the elements, nitrogen is the most difficult to capture and the hardest to keep in captivity," said Dr. Reese. "It is the basis of all explosives, because of that intense desire to set itself free. It is also the essential element of plant food without which vegetation will not grow. So long as the rest of the world was dependent upon Chile, where there are vast natural deposits of nitrate of soda, progress in the manufacture of fertilizers and of the industrial products which are based upon nitrocellulose was bound to be limited, while in time of war a powerful enemy might shut off this source of supply completely.

"We began experiments in the fixation of atmospheric nitrogen during the war. The process originated by Georges Claude, the great French scientist, seemed to offer the greatest possibilities. That has led us into the field of physics as well as of chemistry, for in our ammonia works in West Virginia we deal with pressures as high as 15,000 pounds to the square inch. That pressure is necessary to induce the nitrogen of the air to combine with hydrogen extracted from water into synthetic ammonia. Here is an inexhaustible supply of raw materials—water and air."

CHILE nitrates are still imported, mainly for use in fertilizers, but practically all explosives made in America today, as well as most of the fixed nitrogen used in other industries, come directly from the air.

What has happened in the United States in the manufacture of dyes is a matter almost of common knowledge. Dr. Reese pointed the way. Today we live in a world which is almost a riot of color because of the great volume of cheaply-produced dyes made in America.

After the war Dr. Reese's attention turned to other possible applications in industry of the two chemical substances which formed the base of the explosives business—nitric acid and cellulose. Out of the research he directed came a dozen more revolutionary inventions and applications of chemistry to industry.

Artificial silk, all of which is now known under the general trade term of "rayon," was being made in Europe before the war; a number of American companies were formed after the war to manufacture it in America. And artificial silk is actually nothing but nitrocellulose.

Dr. Reese's initiative in research developed a process of making rayon from wood pulp instead of from nitrated cotton. The method is different from the others; the end-product is the same.

Another universally-used product of the chemistry of nitric acid and cellulose is the artificial ivory once known only as "celluloid" and now by a dozen other names invented by their respective makers.

The most spectacular and revolutionary of all these postwar results of Dr. Reese's research work, however, is pyroxylin lacquer, the new quick-drying surface covering, taking the place of both paint and varnish, and now universally used as a finish for automobiles and many other articles.

"THE pyroxylin lacquer was a development of our pyralin business," Dr. Reese related. "We had been making for several years a thin, transparent lacquer for protecting bright brass work and the like against tarnishing. One of our agents in California had been having trouble with the finish of his car, which required repainting or revarnishing every few months. It occurred to him that this lacquer might serve as a better protection of the paint against the weather. He tried it, found it fairly satisfactory, and got some others to try it.

"He reported his experiment, and we began to study the problem in the laboratories. It was not enough, however, to make merely a varnish. If we could produce a heavy-bodied pigmented enamel which would take the place of either paint or varnish we thought it might have some commercial value.

"The development of the lacquer was purely a chemical laboratory affair. Everybody today is familiar with the revolution it has brought about in only three or four years in the automobile industry. It has made it possible to finish automobiles in a wide variety of colors, reduced the upkeep by eliminating frequent repaintings, cut down the cost of making cars by reducing the time they must spend in the paint shops, and has eliminated the immense storage space formerly required while the paint was drying."

THE discovery came just in time, Dr. Reese pointed out. The world's supply of high-grade resins is dwindling and resins are the basis of the old varnishes and enamel paints. Now cellulose takes the place of resin and the supply of cellulose is illimitable.

"We don't wear as much cotton as we used to, in the form of cotton, but we use more cotton in other forms than ever before," he said. "Rayon, pyroxylin enamels, artificial leathers, motion picture films, all of the plastic materials coming under the general head of 'celluloid' and its similar substances, as well as a large proportion of all of the explosives used in industry, are made of nitrated cotton—nitrocellulose.

"And don't overlook the fact that explosives are even more important in peace than in war. All modern industry is based on the use of explosives. We couldn't build skyscrapers without using explosives to blast out the iron and the coal; we can't dig canals or railroad tunnels without explosives; in New York you can't excavate the foundations for a house without explosives. Farmers use explosives to clear land, to dig drainage ditches. You can't imagine building the new Boulder Dam without using explosives."

"What is going to *(Continued on page 133)*

Reese—A Man Who Always Does the Impossible

(Continued from page 132)

happen next in chemical industry?" I asked.

"God only knows!" exclaimed Dr. Reese. "Whatever it is, it will probably change a few more industries from their present lines to new ones. That is what every new discovery and invention does.

"One great American industry had to reorganize its entire business when the modern high-power incandescent lamp displaced the old-fashioned arc lights on the streets; its business was supplying carbons for the arcs. If it had not been for the scientific research workers whom it called in, that company might have failed. Instead, its scientists found new applications of its supply of raw materials, which have made it greater and richer than its founders ever dreamed.

"THAT is what is going on in American industry today. What industry needs is more research in pure science. Industry is using up available scientific knowledge so rapidly that it won't be long before every scientific fact ever discovered will be utilized for the benefit of all humanity. We need more knowledge, more facts scientifically proved merely because they are facts. Farseeing men in industry today realize that no knowledge is worthless, whether or not it seems to have any immediate bearing on business. Some day, in some way, every new truth finds its application in industry."

Lining the Rooms of Your House

(Continued from page 76)

ever notice that when you are standing on a hill and looking at a view you don't take in the beauties of the things near by? In a room everything is in the foreground, and you shouldn't make the background of walls so distracting as to claim attention. Think of the walls only as the background for the furniture and fittings, and you'll get the idea. What I say about the walls goes for the trim, too."

"Trim? What's that?"

"The doors and the frames around the doors and windows that cover the edges of the plastering. You might say that the trim is all of the woodwork except the floors. It goes a long way toward giving a room its character. Fifteen years ago I'd have had to design it all for you and have it specially made, because the stock patterns of the sash-and-door mills were pretty nearly impossible. But now their designs are made by crack architects, and you can get stock doors and frames, stairs, porches, and everything else that you'll be proud to use. And there are machine-made moldings that are such perfect copies of handwork that they'd fool anybody. You can even duplicate the beautiful woodwork of the early New England houses, and at only part of the cost of handwork.

"SUPPOSE I make some sketches of the dining room and library and living room. They'll be something to start with, and we can change them around to get what you want. And while your wife is working on that part of it," he went on, turning to Mr. Kersey, "you've got a real job ahead of you. We can't go much further without deciding on how the house is to be heated, and that'll be up to you. Here's a list of makers of heating plants. Show them the house plans and ask them for recommendations, and when you've heard what they have to say, you'll have a pretty fair idea of what to do about it."

Mr. Whitman's next article gives valuable advice on selecting the right heating plant for the home you plan to build.

Learn to Fly with Larry Brent

(*Continued from page 46*)

made so dizzy by the first spin that they helplessly put their ships into reverse spins, and continue doing this until the whirling dulls their minds beyond any usefulness and—oh, well. I have heard of pilots holding ships in spins for 5,000 and 6,000 feet, and pulling them out. I'll believe those stories when I see it done! If any flyer has ever made a spin of more than 2,500 feet and pulled out of it without falling off into a reverse spin, I would like to hear about it—with verification.

In that reverse spin of mine, I did what I had been told to do—what I had practiced with a broom handle, night after night, as I sat on my bed. I pushed the stick forward and kicked the rudder against the spin. I have since wondered what was in Randy's mind during that spin. Was he grinning, as he usually did, when I got myself into a tight corner, or did he have that pyrene can in his hand, ready to reach back and let me have it?

We snapped out of the spin into a vertical dive. This time I was steadier. I pulled out slowly. I found my horizon, and although it was going past like water squirting out of a hose, I held the nose steady and kept the wings level.

Enslow looked back at me. Then he grinned. Below my goggles I must have been the color of an unripe lemon. I had never had such a scare, never gone through such a sickening physical experience. He took the controls.

When we touched ground, a few minutes later, in the gentlest of three-point landings, I would not have given a dime for the entire airplane industry. I sat down on the low rail fence near the "lighthouse" on the line and tried to convince my stomach that it was all over. I informed it that we were never going up in an airplane again. "We" were through.

I went over to the field restaurant and drank a cup of hot black coffee. That helped. But it took an hour for that awful physical depression to go away. No, I didn't lose my breakfast. And presently I decided that I would, after all, keep on and fulfill my ambition to become an air mail pilot.

Two hours later I went up again with Enslow for my regular daily lesson. I made some fair landings. Enslow grinned, gave my shoulder a fatherly slap, and said: "Don't worry, kid. You're going to make a flyer."

Next week, I've decided, we'll go up for some more spins. But I know I will never like spins. Some day, years from now, with five or ten thousand hours behind me, when someone asks me if I like spins, I know I will give them the same dull, vague look with which Randy answers foolish questions.

Next month Larry will tell of other thrilling adventures that will make you tingle with the excitement of learning to be a pilot.

Back of the Month's News

(*Continued from page 51*)

veloped. Shortly afterwards, antisnake-bite serums were also evolved in laboratories in Brazil and in this country.

Because it is extremely irritable, the rattlesnake is the greatest offender among many poisonous snakes in the United States. The rustle of wind in the leaves or even a distant glimpse of a man will excite its fear and arouse its defensive fury. Experts are not certain whether it must vibrate the tip of its tail before it can strike, but agree that it never strikes without warning. Any sound will cause the rattler to coil itself into a spiral. According to Dr. Calmette, it lifts its head eight or ten inches after coiling. At the same time, the tail goes up and begins its rattling. In this position the snake remains, ready to strike, as long as it believes itself menaced.

Whenever you hear the rattling noise, experts advise, stop dead in your tracks. Don't make the slightest motion. If you do, the rattlesnake will strike. If you don't it forgets all about you, uncoils and goes away.

Spending Millions for War on Mosquitoes

THE other day, Dr. A. S. Barrett, chief of the Milwaukee Public Museum expedition to East Africa, returned with thrilling tales of high adventure in the jungle. The explorer told of shooting a charging rhinoceros at a distance of only twenty feet and of killing other wild beasts in self-defense. But he and his party agreed that of all the creatures that menace man on the Dark Continent the most ferocious is—the mosquito!

Emerging from jungle swamps in swarms of millions, the insects descended nightly upon the helpless men, robbing them of sleep and even endangering their lives. All means of combating the pests proved unavailing. Small wonder that the tortured travelers preferred the attacks of animals they could fight with gun and hunting knife.

One doesn't have to go to Africa, however, to learn that the mosquito is one of the most cruel enemies of mankind. Scientists have calculated that in the United States 7,283 gallons of human blood—the equivalent of the total vital fluid of more than 3,750 adult persons—is sacrificed each year to mosquitoes.

On a "battle front" stretching from Maine to Florida, thousands of men are engaged each year in a battle to exterminate the pests, and millions of dollars are spent. The weapons include ditch-digging tanks, rotary oil-sprays, power pumps, tide-gates, gasoline engines, and electric dynamos. These are used to drain swamps where mosquitoes breed, or spread oil on waters that cannot be drained, to kill their larvæ or "wrigglers."

MOSQUITOES breed both in salt and in fresh water. The killifish or salt minnow is the great natural enemy of the immature salt marsh mosquito. Hence, 140,000 acres of salt marsh in metropolitan New Jersey and the seashore resort region have been trenched with some 40,000,000 feet of narrow ditching in such a way as to cause the water upon them to rise and fall with the tides, thus affording passageways for man's ally—the killifish!

In the New Jersey salt marshes it has been found necessary to fence out the tide with dikes! From these diked areas the water is removed by gravity through tide gates. Where the marsh is too low, the water is pumped out.

The huge drainage pumps used in this process draw 2,800 gallons of water from the marsh per minute. And as examination has shown that there are about 400 eggs, larvæ or "wrigglers" to each surface gallon of marsh water, each of the machines is responsible for the destruction of 1,120,000 potential pests per minute. Maintaining that average and working day and night, one pump would kill 67,200,000 in an hour, 1,612,800,000 per day, and 11,289,600,000 a week!

How necessary is such wholesale destruction becomes apparent when you realize that one mosquito breeds 159,875,000,000 offspring a year! However, "only" half of that number, or 79,937,500,000, are females which do the buzzing, biting, and stinging.

People in the Public Eye

(Continued from page 30)

delphia Centennial Exposition at $2.50 a day. He is Gustav Lindenthal, who was 79 years old in May and says he expects to cross his beloved Hudson Bridge. In robust health, his nearly six-foot figure erect and an athlete one of whose pet hobbies still is boxing, there seems to be no reason why this expectation should not be fulfilled.

The chief engineer of the North River Bridge Company, who has planned more bridges and tunnels than any other man in the United States and is doubtless the greatest bridge builder in this country, arrived in America in July, 1874, when he was twenty-four years old. He stayed in New York just long enough to catch the next ferry for Jersey City, where he boarded a train for Philadelphia. Carefully tucked away in an inside pocket was a purse containing $200—all he owned in this world. Friends in Europe had been so emphatic in their warnings against the thieves and pickpockets of New York City that he didn't dare to remain there for the length of time it would have taken to eat a sandwich!

The previous year, he had visited the International Exhibition in Vienna, Austria. This had given him the idea that Philadelphia, which was then preparing the Centennial Exposition, was the right place for a young, ambitious draftsman. So he resigned a good position as division engineer on the construction of one of the Swiss railroad approaches to the St. Gotthard Tunnel through the Alps, which he had held since finishing his technical studies in Brünn, his birthplace, and Vienna. In his vacations he had worked as a carpenter, an apprentice in a machine shop, and as a mason.

REACHING Philadelphia, he realized he picked a poor time to migrate to the New World. As a result of the panic of 1873, there was wide-spread unemployment in the United States. He had no letters of introduction. He trudged from office to office, but no engineer or architect would employ him. Weeks passed. His $200 dwindled alarmingly. Then he took a drastic step. He invested $9 in a set of secondhand mason's tools and took them out to the Centennial grounds in Fairmount Park. Here he found a foreman who spoke "Pennsylvania Dutch." The man was supervising a gang of laborers digging a hole.

"You stand over there," he told young Lindenthal, pointing to a group of waiting, jobless masons. "When I raise my hand, you come."

He raised his hand on the fourth day! By that time, the digging was finished. Despite the rush, Lindenthal was among the first in the ditch, the site of Memorial Hall, one of the Centennial's permanent buildings which still stands in Fairmount Park.

The Austrian stone mason gave such striking evidence of possessing ideas that his background and education were soon discovered and it was but a few weeks before he was given a draftsman's job. After that, he was quickly promoted to the post of chief of the office where all of the wrought-iron work for the Exposition was designed.

The year 1877 saw Lindenthal established in Pittsburgh as a consulting engineer, specializing in building railroad bridges and tunnels. From 1879 until 1881, he was bridge engineer for the Atlantic and Great Western Railroad, now part of the Erie system. During that time he replaced a large number of wooden Howe truss bridges with iron structures for heavy locomotives. As chief engineer for several railroads between 1882 and 1890, he built many railroad and other bridges in Pennsylvania, Ohio, West Virginia, Illinois, and Indiana. He received the Rowland medal from the American Society of Civil Engineers in 1883 for his Monon- (Continued on page 136)

People in the Public Eye

(Continued from page 135)

gahela River bridge at McKeesport, Pa.

Lindenthal came to New York in 1892. There, he prepared plans for the reconstruction of the Brooklyn Bridge. He was one of the board of six consulting engineers who planned the tunnels and terminals of the Pennsylvania Railroad under the North and East rivers. He also was the designer of the beautiful Hell Gate Bridge over the East River, the largest steel-arch bridge in the world, crossing from Long Island to Ward's Island in a single braced steel span of 1,000 feet. While Commissioner of Bridges from 1902 until 1903, he completed the Williamsburg Bridge and made the plans for the Manhattan and Blackwells Island (now Queensboro) bridges. Lindenthal, who is the author of numerous works on engineering and bridge building, holds honorary doctorates from the Polytechnical Schools of Brünn and Vienna and of Dresden, Germany, and is a member of virtually every great engineering society in the United States and Europe.

America's Fastest Flyer

A FEW weeks ago the Distinguished Flying Cross was awarded to Lieutenant Alford J. Williams, crack speed pilot of the Navy. In a citation accompanying the award, it was set forth that the high distinction was conferred upon Williams for his death-defying experiments, such as outside loops, upside-down spins, and inverted flights that enabled him to evolve certain principles the practical application of which has resulted in greater safety in aerial maneuvers and increased accuracy in testing aircraft. At about the same time another award was made to him by the Guggenheim Fund for his services in advancing the science of flight.

These rewards, of course, are richly deserved, but to the general public and to aviation enthusiasts particularly "Al" Williams is better known as "America's fastest flyer." And that title is not only honestly won, but it scarcely does justice to the prowess and skill of this picturesque American airman.

Although, through a series of unfortunate delays, Williams was forced out of the Schneider Cup races at Venice in September, 1927, when British Flight Lieutenant S. N. Webster captured the trophy with a speed of 281.488 miles an hour, the American two months later unofficially attained a speed of 322.6 miles per hour at Mitchel Field, N. Y., in the converted racing plane of his own design he had prepared for the Schneider contest. This bettered Webster's mark by more than forty miles and surpassed by just about six miles the speed of 318.57 which Major Mario de Bernardi, Italian army ace, had achieved over the Lido course forty-eight hours previously, and was faster than anyone has flown before or since—a speed of, roughly, five miles and a third per minute!

For the last two years, Williams has been working quietly on plans for a racing plane that, in the Schneider cup races, will bring the world's seaplane speed record back to the United States. It is believed the project is sponsored and financed by a group of patriotic American sportsmen and patrons of aviation.

Williams first achieved international fame as an air racer in October, 1923, when, as a member of the team of Navy pilots participating in the International Air Races at St. Louis, Mo., he won the Pulitzer Trophy with a speed of 246.67 miles an hour for 200 kilometers in a Navy R2C1 plane. This remains the world's record for that distance.

He bettered his own mark the following month, when he established the then world's record for airplane speed of 266.6 miles an hour at Mitchel Field. But in the Pulitzer Trophy race of 1925 he dropped to 241.71 miles per hour, the event being won by "Cy" Bettis of the Army with a speed of 248.99 miles per hour.

"Al's" present ambition is said to be to win the 1929 Schneider Cup with a record of something approaching 325 miles!

Williams, aside from being America's and perhaps the world's fastest flyer, is probably the only aviator who is also a lawyer and a baseball player! Born in Bronx County, N. Y., thirty-five years ago, he was educated at Fordham University, N. Y. Upon graduation from college, he signed up as a pitcher with the N. Y. Giants, and played professional baseball for two seasons. Meanwhile, he took up the study of law at Fordham.

When the United States entered the World War, "Al" enrolled in the Naval Reserve Force. At the end of a ground course for aviation at Boston Tech., he went to the Naval Air stations at Bay Shore, L. I., and Pensacola, Fla., for flight training. This completed, he stayed at Pensacola to teach.

While engaging in his air races and unequaled aerial experiments, Williams found time to complete his law studies at Georgetown University, Washington, D. C., from which he received an LL.B. in 1925. The following year, he was admitted to the New York Bar. Williams, who is married, at present is connected with the Bureau of Aeronautics of the Navy Department, at Washington.

Discoverer of Stars

NOT long ago, Dr. Harlow Shapley thrilled the scientific world with the announcement that the hub of our universe, sought by astronomers for centuries, had been located by the Harvard College Observatory, of which he is the director. This stellar nucleus, around which our whole galaxy of heavenly bodies spins in space like a gigantic wheel, the Harvard astronomers placed at a distance of 47,000 light-years from the earth in the direction of the constellation Sagittarius.

Just recently, it came to light that it was a young girl, Miss Henrietta H. Swope, who was chiefly responsible for this momentous gain in astronomical knowledge. Dr. Shapley insists it was her discovery of nearly 400 new variable or "winking" stars in the Milky Way that permitted him to make the intricate calculations which finally enabled him to put his finger on the center of our universe.

Miss Swope, the daughter of Gerard Swope, president of the General Electric Company, is one of the assistants on the Harvard Observatory Staff. She was graduated from Barnard College, N. Y., only three years ago. Astronomy had been her hobby in undergraduate days, so when, after a year of social science study at Chicago University, she learned of an opening in the department of variable star research at Harvard, she returned east and obtained the position.

But it shouldn't be imagined that Miss Swope was assigned to observation duty on some desolate mountain peak. Of late years, there have been many changes in astronomical research. Photographic plates now replace personal observation to a large extent and often the microscope takes the place of the telescope, not only changing astronomy, at least partly, into a "daylight science," but also making it one which women may pursue without hardship.

About the time Miss Swope started on her job, Dr. Shapley had begun a comprehensive investigation of the Milky Way to determine the distances of its individual stars, nebulae and stellar groups. He had devised a new method involving the *(Continued on page 137)*

People in the Public Eye

(Continued from page 136)

measurement of the variability of the changes in the luminosity of a star. The new method made possible the determination of distances 100 times greater than those that could be measured under systems previously used, but its application demanded mathematical ability of a high order. At Barnard, Miss Swope had majored in mathematics, and so this part of the research work fitted her like a glove.

Dr. Shapley divided the Milky Way into 240 fields for the photographic survey, in which some 60,000 plates in the Harvard files were used. Miss Swope was assigned to one of these fields to discover as many new variable stars as possible. In her first year, she found very few. But last year she uncovered no fewer than 385 tiny stars that had never before been known to fluctuate in light.

Each one of these stars she measured photometrically, charting its period of variation from minimum to maximum luminosity by comparing the various photographic plates on which it appeared. Then she applied slide rule and logarithms to translate the result of her studies into statistical data.

Upon the completion of her assignment, Dr. Shapley made an analysis of her work. A few weeks later he told the scientific world that one of the great quests of the centuries was at an end—the hub of the universe had been located at last!

Thus, at the age of only 26, Miss Swope has become an outstanding figure in scientific research, upon whose work the attention of astronomers throughout the world is focused. She is the author of two articles on variable stars, one of which she prepared with the assistance of her distinguished director.

Naturally, Miss Swope can't help but be thrilled by the success of her efforts, but she refuses to accept credit for the discovery of the center of the universe.

"That," she says, "belongs to Dr. Shapley. He is the scientist. I am only the handmaiden of science."

Here Are Correct Answers to Questions on Page 51

1. It does no harm to any modern watch or plain clock to turn the hands backward to set it to the correct time. But if a clock contains striking or alarm mechanism it should be set only by moving the hands forward. Really high grade clocks that strike the hours are so constructed that no harm will come to the mechanism no matter which way they are set, but it is better to play safe.

2. The normal position for a pocket watch is winding stem up, but the watch may assume two other positions in the pocket if the stem tips over one way or the other. Then when the watch is placed on the bureau at night it may be placed face up or face down, a total of five positions. Theoretically, if the balance wheel, the hairspring, and the pallet are in absolutely perfect balance the watch will run at the same rate in any position. Any unbalance results in a pendulum action that is varied with position. Adjusting for position therefore means careful balancing.

3. The principal difference between a pocket watch and a chronometer is in the construction of the parts that drive the balance wheel. The chronometer balance wheel is larger and heavier and the escapement is so made that it oscillates completely free of the escape mechanism except for a brief period in one direction. Chronometers are hung in gimbals so that the balance wheel always oscillates in a horizontal plane.

4. No timekeeping (Continued on page 138)

Here Are Correct Answers to Questions on Page 51

(Continued from page 137)

mechanism keeps perfect time. Friction cannot be entirely eliminated nor even made uniform. Temperature correction is never perfect. Changes in the density of the air have some effect. A very fine pocket watch, wound regularly and handled carefully, should show an error of not more than half a minute a month and may do even better for several months in succession.

5. A cheap stop watch of the type sold for a few dollars is simply an ordinary watch mechanism fitted with a solid balance wheel not compensated for temperature, positions, or anything else. Pressing the button lifts a brake out of contact with the balance wheel and the watch starts. Another pressure stops the balance wheel and a third pushes the hand back to zero by means of a cam. A high grade stop watch has a finely compensated mechanism that runs continuously and the hand is operated by throwing fine toothed gears in and out of mesh. Split second stop watches have two hands, the two traveling as one until a pressure on an additional button clamps one of them.

6. The term "railroad accuracy" has no very definite meaning. Most railroads require that men who control the timing of trains carry a 21-jewel, 16-size, lever set watch and each watch must be cleaned and inspected by an approved watch repair firm once a year. The number of jewels beyond 17 has no bearing on the timekeeping qualities of a watch other than the fact that a watch has 21 or 23 jewels is good evidence that it is of high grade construction throughout. Sixteen-size is specified because the thin, small watches now so popular are not sufficiently reliable. Lever set is specified so as to eliminate the possibility of the user accidentally disturbing the setting of the watch while winding.

7. The earliest recorded timepiece is the sundial. It was of no use on a cloudy day. Following that came the clepsydra, a water clock, used by the Greeks and Romans. It consisted of a container from which water was allowed to run through a small orifice. The sand glass, still much used for timing the boiling of eggs, preceded clocks and watches.

8. The term "isochronism," as applied to a timepiece, refers to its ability to run at a uniform rate at all times during the period between one winding and the next. A low grade watch not adjusted for isochronism may gain time during the first hours after winding and then lose near the end of the run. Such a watch might show a small daily variation and still be unfit for use in accurate timing because of alternate slow and fast running.

9. A properly constructed and accurately compensated pendulum clock is the most accurate timepiece available. In fact the introduction of the pendulum marked the first important step in the development of a timepiece that would really keep accurate time.

10. The method of dividing the day into two periods of twelve hours, the hours into sixty minutes, and the minutes into sixty seconds is a relic of the sexagesimal system that prevailed before the decimal system was finally adopted. Our method of computing time and our method of measuring angles in degrees, minutes, and seconds are the only remnants of this obsolete system.

Another interesting series of questions and answers that will help you test your knowledge will appear in next month's issue.

Crushed in the Jaws of Arctic Ice

(Continued from page 25)

ask for grub. On this ship men who don't work don't eat.'

"The skipper's bluff carried him through. In a couple of days the gang got hungry and put canvas on the vessel and she made port with only one more death. It turned out the disease was typhoid fever, which we must have got in our water. The skipper was sport enough not to make an official report of the mutiny. As a result the same crew shipped over again, and many of them stuck by the Old Man for years."

"What happened to the leader?" I asked.

"Oh, the skipper got absent-minded and left him in the lazarette so long that he had to go to a hospital when we got in. I heard afterward he got well, but wasn't much good any more. Probably served him right."

At this point in Bartlett's tale a near-by factory whistle shrieked the news that it was noon.

"SHE dips," muttered the captain, meaning that the sun had passed the meridian. He opened a fine oak box containing his chronometer.

As he wound the expensive timepiece, which read Greenwich time, he turned to me and said half-apologetically: "I don't own this fellow. Alarm clock is good enough for me."

"Alarm clock! And you can make a safe landfall?"

He grinned. "Oh, once in a while we have a little trouble. I remember a few years ago a skipper named Ed Simmons, coasting home from Boston, got in thick weather. After a couple of blind days he saw the loom of the land ahead. Ran in close until he saw a farmer down near the beach.

"'What part of Newfoundland is that?' he sang out.

"The farmer didn't answer until he'd given another hail. Then the man said: 'This ain't Newfoundland. It's Nova Scotia!' You should have seen Ed beat it, lest he be recognized and laughed out of every pub down the coast."

Such navigating seemed pretty precarious to me, and I said so.

"'Twould be for a deep sea voyage to a clear coast. But don't forget I'm talking about those who have to feel their way for hundreds of miles without a sight of the sun, no sort of speed or drift for their dead reckoning.

"A few years ago five ships were lost in one blow down the Labrador. My uncle Isaac Bartlett's brig, *The Brothers*, was caught off Cready by a knockdown northeast gale and ran for the tight ice inshore. She was caught in pressure and crushed to pieces. The men escaped by clambering over the ice.

"NEXT morning Uncle Isaac walked down the coast to see if he could find shelter for his men. He happened to glance out across a stretch of ice-free ocean where there was a reef about three miles offshore. Through his glasses he caught sight of something moving on the small patch of rocks. At first he thought it was a seal. Then he saw it was a man.

"He found help and reported the man on the reef. Remember it was early spring and bitterly cold; and of course the spray of the sea was washing over the poor devil. But when a boat put out and took him off he was still alive.

"'I'm from the *Huntsman*,' he whispered, scarcely able to talk. 'She went down inside.'

"Then we knew what had happened. In the gale and fog the skipper of the *Huntsman* had found the opening between the reefs and had driven his ship through as straight as a die; a fine piece of piloting that the best navigator in the world could be proud of.

"The trouble was (Continued on page 140)

Crushed in the Jaws of Arctic Ice

(*Continued from page 139*)

that surf and slush ice lay beyond. Together they smashed the ship and drowned the whole crew—all but one man, the fellow who was on the reef. Knowing what was ahead, he had had the quick wit to hop overboard as the *Huntsman* shot by. He swam a few strokes to the rocks and climbed up."

"But how was he able to live?"

Bartlett shrugged. "A tough one, he was. Both legs were broken by the seas when he was picked off. Yet he lived."

"IRON men and Wooden Ships" is no idle phrase for such mariners. Indeed, only an iron man could survive the fare Bartlett described as the usual diet. There was usually on the Newfoundland vessels only one big meal a day. This was served out about noon. Seal meat, strong and blubbery, was the main staple. Three times a week a delicacy was added: boiled flour-pudding and pork.

"This mass was about the color of gutta percha and almost the same consistency," he explained. "Tea sweetened with molasses and hard bread were served in addition at each meal."

"But can any man stand swimming in cold sea water?" I persisted.

For reply Bartlett thrust his wrist clear of its sleeve.

"See that scar? Got that when I was mate on the *Grand Lake*. I was working on the forecastle, clearing up the ground tackle after we had run out of a northerly port in winter time, when I lost my balance and went over the rail. In reaching for a hold I sliced a piece of flesh clean out of my forearm.

"The fool sailors were so surprised—maybe glad, too—that they just stood there like a lot of wooden Indians for a moment or two and didn't utter a sound. Then one of them piped up and passed the word that the mate was overboard.

"Instantly they broke for the rail over which I had just disappeared and looked down into the cold water to see if I was hanging on. Well, I was hanging on, all right; only it was the other side. I had caught hold of a wire line that ran from down to the lower part of the stem and hauled myself up.

"I climbed on deck, dripping wet and pretty cold in the raw wind just in time to hear another man sing out: 'The mate's gone!'

"'Yes, but he's back again!' I let go right in the fellow's ear. 'Now turn to, you cock-eyed loafers!'

"THEN there was another time on one of my early sealing trips when I was little more than a lad. I'd killed and skinned a fine seal. While I turned my back the ice opened and the next moment a lane of open water separated me from the pelt.

"I hated to lose it because I was trying to make a name for myself. I knew that the captain kept a record of the skins each of his men brought in, and the size of each. In less time than it takes to tell I made up my mind to get that skin.

"Although the temperature was down around zero I slipped out of my woolens and underwear and plunged in. Shock of the cold water on my bare skin was like getting a thousand volts of electricity right through my body. But I made the other side and crawled out on the ice. As the air was much colder than the water I didn't hesitate. I grabbed the skin, swung it around my head, and tossed it back.

"When I dived in again I was so numb that I didn't even feel the water. I thought I'd perish before I got dressed. But I finally managed it, then ran and swung my arms until feeling came into my body again. I didn't even catch cold.

"On the Polar Sea with Peary falling in was more serious. On the North Pole trip of 1909 we had temperatures around sixty degrees below zero.

"One day I was crossing a lead on young ice and broke through. The water felt *warm*. That was because the sea, you know, never gets colder than twenty-eight degrees above zero, no matter how cold the air is. The surface may freeze, but the water beneath remains at practically the same temperature all the time.

"Luckily the Eskimos, Etukeshuk and Egingwah, were with me. They had me out inside of three minutes. Instantly the water began to freeze on my clothing. And I would have perished had not they stripped my soaking furs off and shoved me into my sleeping bag. Then when I got warmed a bit they passed in dry clothing and I was dressed and out and on the trail again in half an hour."

Speaking of his work with Peary, Bartlett reminded me of what I consider his greatest adventure, the loss of the steamer *Karluk*. He commanded her in the summer of 1913, when Stefansson took the Canadian Arctic Expedition north through Bering Straits and along the coast of Alaska, with a view of exploring the Polar Sea to the eastward.

THE *Karluk* was caught in the ice and blown northward without Stefansson aboard. The leader had gone off hunting just before the storm, and when he returned his vessel had disappeared.

"She drifted out into the polar pack," Bartlett reminded me, "struggling against the increasing pressure. The sun left us in early November, not to return again until spring. The temperature fell into the fifties below zero.

"On New Year's Day, 1914, we were all sitting huddled around our little stove below when the pressure suddenly grew worse. Provisions were hurriedly taken on the ice. Ten days later the *Karluk* gave up the uneven battle and sank.

"We had a tough time making our way south to Wrangell Island. Six men died. From Wrangell I continued on to Siberia and finally reached Alaska where I took out a rescue ship in the summer."

"Wasn't there some incident of that whole adventure that sticks with you?" I asked. Perhaps it was a morbid thought, but it seemed to me that the party's fearful months of cold and starvation must have left at least one high point of dramatic value on the captain's memory.

HE NODDED as he refilled his pipe. "Yes," he said, "there was. I had escaped from the *Karluk*, I hadn't frozen on the ice, I had somehow got across the hard miles to land, and then I almost failed!"

What a situation! Success in sight after long harrowing months of frozen feet, short rations, heavy sledges. Surely Bartlett was about to divulge some hitherto unconfessed thrill, when he trembled on the brink of eternity.

"When I reached the Siberian coast I could not go on without native help. I found a hunter who said he would guide me eastward. 'How much you pay?' he asked in the little English he had learned from traders and whalers.

"I had brought forty dollars in gold with me from the *Karluk*. As it was vital that I hurry I thoughtlessly told him I'd pay him the full amount. I could have bitten my tongue off the next instant. Any trader would have had the sense to offer a small price and then bargain up towards what the native asked.

(*Continued on page 141*)

Crushed in the Jaws of Arctic Ice

(*Continued from page 140*)

"'Show me money,'" said the native.

"But I refused. Then he accused me of not having any. We argued for two hours. He knew only about twenty-five words o English and I knew about three words of his dialect. He bawled at me in Eskimo and I at him in English.

"There we were out on the wind-swept desolate north shore of Asia, with the thermometer twenty below and nothing but snow and ice as far as the eye could see, and jawing at each other for all we were worth, and not understanding a thing the other said!

"Well, the end of it was I convinced the fellow I had some money with me and he was avaricious enough to want to get at it. So he guided me east, I keeping my eye on him every inch of the way to see that he didn't attack me and steal my pile. Every now and then we'd break out and argue about the forty dollars, seeing which could yell the loudest.

"AFTER we had gone far enough for me to find the trail the rest of the way he suddenly decided to desert me. I suppose he was afraid we'd meet traders and I might tell them he had tried to rob me. I gave him five dollars for what he had done and showed him the rest of the money, which made his eyes stick out half a fathom!"

I asked Captain Bartlett one question that had been on my mind for a long time.

"Were the old skippers as severe with their men as they are described by fiction writers?"

The captain doubled up one fist and gazed at it with a reminiscent look in his eyes.

"Yes and no," he replied. "Yes, the old-fashioned skipper never hesitated to use force if he felt the situation needed it. And no, he didn't beat up a man just for the sake of being rough. Needless violence would only have damaged the respect which the good skipper always wanted from his men, no matter how poor or disloyal a lot they were.

"IN MY day a good skipper was usually a fine physical specimen who could stand up and thrash any average seaman in a knockdown fight. That's why he was picked as skipper.

"I sailed as mate with Captain William Cross of the *Strathavon* out of Sydney with a cargo of ore and coal. One day a big loud-mouth came aboard with a longshore bun on and got fresh with the old man. Captain Cross didn't blink an eye, but took the fellow's lip without a word—until he'd had his say. Then the captain took one crack at him and slammed him so hard to the deck that it took the cook half an hour to bring him to.

"Another time Captain Cross lost his temper with the whole forecastle gang. Without hesitation he strode forward and hopped down the ladder, spry as a monkey. As first mate, it was my job to follow; also I was afraid the old man would meet more than his match.

"But he was a veteran at such work. He knew the value of surprise. Before the men knew he was around he pasted the nearest one on the jaw and dropped him cold. The next one stepped forward to meet the captain but rolled into a lower bunk holding a cracked chin.

"I had arrived when the others rushed. The captain sidestepped and sent the leader staggering against the bulkhead. By this time the heart had gone out of the crew. Captain Cross never said a word. He just turned and went up the ladder. I found him on deck brushing his sleeve where he had rubbed against some fresh paint. Strange to say, he was more popular than ever after that little scrap."

I thanked Captain Bartlett and left him feeling more than ever that the mariner is a distinct species of human being and like none other on the face of the earth.

At the Throttle of the "Big Hog"

(*Continued from page 53*)

the Keyser yards—the thing that impresses me most is the way railroading has become safer and easier. When, after I had worked in the yards and shops for a few years, I started firing freight hogs in 1896, there were plenty of accidents, some of them bad ones. And no wonder—freight cars had link-and-pin couplings in those days—one reason why there were so many one-armed and one-legged railroaders around!—and most of the cars had hand brakes, with only an occasional air brake car. Locomotives were little things compared to what they are today—the old 500's were only sixty tons—and a train of from sixteen to twenty light cars needed a helper engine to get it over these grades. Then, after a while, air brake equipment became more common, automatic couplers came into universal use, locomotives got bigger and trains longer and heavier—and railroading became safer as well as easier.

"Some of the real old-timers didn't think it would. I remember when they sent the first 1600's to this division—seventy-three-ton engines. Old Frank Snyder took a long look at one of them, rushed into the office, and slammed his hat down on the boss's desk. 'I'm through!' he yelled. 'I'm not going to risk my life on an engine that big!' He meant what he said, too—he quit!

"WONDER what poor old Frank would say if he could see this 5501, or its year-older brother, the *Lord Baltimore*—both of them built in the company's Mt. Clare Shops in Baltimore. An engine with a weight of 275,000 pounds on its eight seventy-four-inch driving wheels, with a tractive power of 68,200 pounds, and a total weight of 400,000 pounds. An engine fifty-five feet long from the point of its pilot to the end of its deck—and a few inches over 100 feet long with its 258,000-pound all-steel tank tender, which has a coal capacity of twenty-one and a half tons, a water capacity of 15,100 gallons, and a total weight of 493,000 pounds fully loaded.

"WONDER what old Frank would think of a fire box eleven feet by eight feet, and with a grate area of ninety square feet, stoked by an automatic stoker—the strongest-backed fireman on the division couldn't handle that job properly with a coal scoop. Wonder what he would have to say about the rail washer, which washes the sand off the rails after it has done its work of giving the drivers a good grip—washes it off so that the passenger cars behind will have a smoother ride. An engine a lot bigger than he ever dreamed of—and one easier to handle than were his little old 500's. Yes, *sir*—a mighty fine engine! The biggest mountain-type locomotive in passenger service. Other roads may build bigger engines, but if there's ever a better engine built, the Baltimore and Ohio will have to build it!"

In that last remark of Jim Pugh's you can catch a glimpse of the spirit of the highest type of engineer—outspoken pride in his locomotive, and deep-rooted loyalty to his railroad.

The *Philip E. Thomas* and the *Lord Baltimore* are the highest development of the mountain-type locomotive—which is a locomotive with four engine-truck wheels, eight driving wheels, and two trailer wheels—technically a 4-8-2 type locomotive. While Jim Pugh was telling me about its mechanical marvels my thoughts went back a hundred years to the little *Tom Thumb*, forefather of all the Baltimore and Ohio's big modern locomotives. There's an amusing—and true—story about that little engine.

In 1829, rails had been laid from Baltimore to Ellicott's Mills, a distance of only a dozen miles or so, but with sharp curves and steep grades. Steam locomotives had been built and successfully operated, but it was thought that for this line horses would furnish the best motive power. Peter Cooper, a New York merchant with commercial interests in Baltimore, saw the shortsightedness of this policy, and built a small experimental locomotive to prove that steam could take the place of the horse. His *Tom Thumb*—it wasn't much larger than a modern hand car, and had an upright boiler with tubular flues improvised from old rifle barrels—was completed early in 1830, and on a fine August day demonstrated its powers by drawing a light car filled with railroad directors and their friends out to Ellicott's Mills at a speed of fifteen miles an hour. Peter Cooper was delighted—his engine had proved that it could conquer curves and grades.

NOW entered the villain—a stagecoach proprietor, who had no use for railroads. The railroad was double-tracked as far as Relay. The stagecoach man pulled strings, with the result that when the *Tom Thumb*, headed for Baltimore, reached that place, a light car, drawn by a fast gray horse, was waiting. *Crack!* went the driver's whip as the engine came abreast of him—and the race was on.

Peter Cooper opened his throttle, and the *Tom Thumb* leaped into the lead as the directors cheered. Cooper jammed more wood into the fire box, and the *Tom Thumb* increased its lead. But the steam pressure mounted too high, the safety valve lifted—and the little engine "popped off!" The waste of steam caused it to slow down, and Cooper and the disgusted directors saw the gray horse gallop past them to win one of the queerest races ever run.

* * *

Now we were well out on the Seventeen-Mile Grade—that uniform 2.4 percent incline of steel rails that carries the Baltimore and Ohio's line to the top of the Alleghenies. The locomotive swayed and pounded, and in the cab there was unceasing uproar—the rumble of wheels over rail joints, the hiss of escaping steam, and always the monotonous *clank-clank-clank* of the duplex stoker as its feed worm carried crushed coal from the tender to the elevators just aft of the fire box door, then up through the elevators into the fire box, there to be distributed with more than human skill.

"SAVES your back, doesn't it?" I said, nodding toward the stoker.

"Saves me shoveling six tons of coal between Keyser and Grafton," replied Fireman Fazenbaker, grinning broadly.

Through cut and over fill, around curve and along tangent, the 5501 thundered on through the darkness—to me a thrilling and never-to-be-forgotten ride—to the other three men in the cab just another run over the West End.

Now a lonely square of light came in view ahead—the window of a telegraph tower. As we approached we saw a white light burning on a board protruding from that window. No orders! "Clear board!" called Fireman Fazenbaker. "Clear board!" echoed Engineer Pugh. If there had been a red light burning on that board it would have meant that train orders waited there, and Jim Pugh would have had to stop even the *National Limited* to get them.

On through the night, along lonely mountain sides, through infrequent towns all dark and sleeping—and then a green light ahead.

"Caution!" said Engineer Pugh. "Caution!" repeated Fireman Fazenbaker, peering out of the left-side window. We slowed down, after a while coming to a gentle stop—no use in waking the sleeping passengers in the Pullmans back there. Torch

(*Continued on page 148*)

At the Throttle of the "Big Hog"

(Continued from page 142)

and long-spouted oil can in hand, Pugh was on the ground and busy oiling the locomotive almost before its drivers ceased turning. Lanterns gleamed ahead. Then a helper engine backed slowly down to us, and coupled on ahead to assist us over the "hump."

* * *

The helper cut off, we were away over the eighteen miles of rolling plateau country on the crest of the mountains, and soon we were drifting down the Cheat River Grade. Fireman Fazenbaker turned a wheel that shut off the driving steam from the stoker, and lighted a cigarette. "Now we're on *my* side of the hill," he said.

Grafton, and good-nights. The 5501 rumbled away toward the roundhouse, there to be carefully inspected and serviced for the return trip. The *National Limited*, hauled by another locomotive and manned by another crew, rolled away toward St. Louis.

"AFTER they have reported anything that needs adjustment or repair," said Charley Schuh as we walked across the station platform to the hotel door, "the enginemen can turn in and sleep until a half hour before leaving time in the morning. The 5501 will be taken care of by the mechanical force at the roundhouse. After a locomotive has given about 75,000 miles service—say every eight months—it is sent to the shops for a thorough overhauling." He looked at his watch. "Maybe you noticed," he says, his casual tone not concealing his pride, "that we made up that twenty minutes of lost time."

Wheat cakes and black coffee at dawn in the all-night railroad restaurant at Grafton station. Then aboard the 5501 again—a 5501 all shining from the attentions of the roundhouse men. Jim Pugh nodded a good-morning; Fireman Fazenbaker manipulated the bell cord and we were off again, this time hauling the *National Limited* toward New York—back across the mountains through the clean air of early morning.

Back in Keyser, a Pacific—4–6–2—type high-speed passenger engine took the place of the 5501 on the *National Limited*. "She's a flyer," said Charley Schuh. "It's all downhill from here for a hundred miles to Weverton, the end of the East End of the Division—and then all downhill or level into New York. We're the fellows who do the two-fisted work on this railroad!"

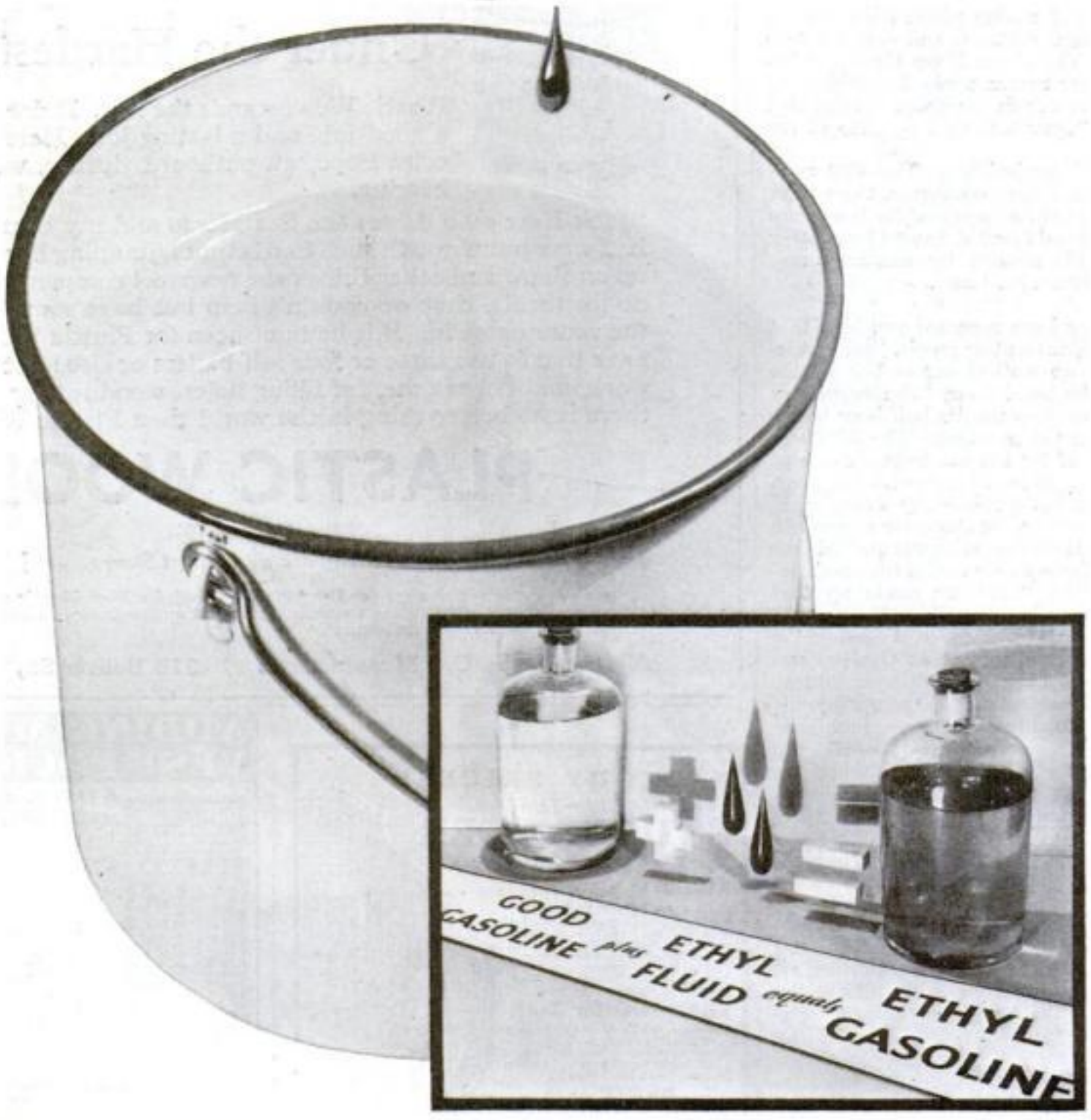
"NO," SAID Jim Pugh, sitting with his hands clasped in his lap in the road foreman's office, "nothing exciting ever happened to me. Nerve strain? No, I've never felt any. Wrecks? No—it's been my aim to keep out of them. You see, I'm a careful sort of man. You see, I don't get time to do anything exciting—I make two round trips to Grafton, and then lay off a night here at home. What do I do on my days off? Oh, just stay around home—fish a little in the spring, and hunt a little in the fall. I'm mighty sorry, and I'd like to help you—but I'm afraid that you can't make a story out of me!"

From the window I watched him cross the station platform—a stubby, solid sort of man, who watches carefully where he is going, and at each step places his foot solidly on the ground.

No, not much of a story in Engineer Jim Pugh. He lacks the romance and color of the legendary Casey Jones. But when I turn in on a sleeper I like to think that a Jim Pugh is at the throttle up there at the head end, and another Jim Pugh at the throttle of the train behind us.

And the best part of it is that Jim Pugh, as well as being a real man, is typical of the American passenger engineer!

A *literal* "drop in a bucket"



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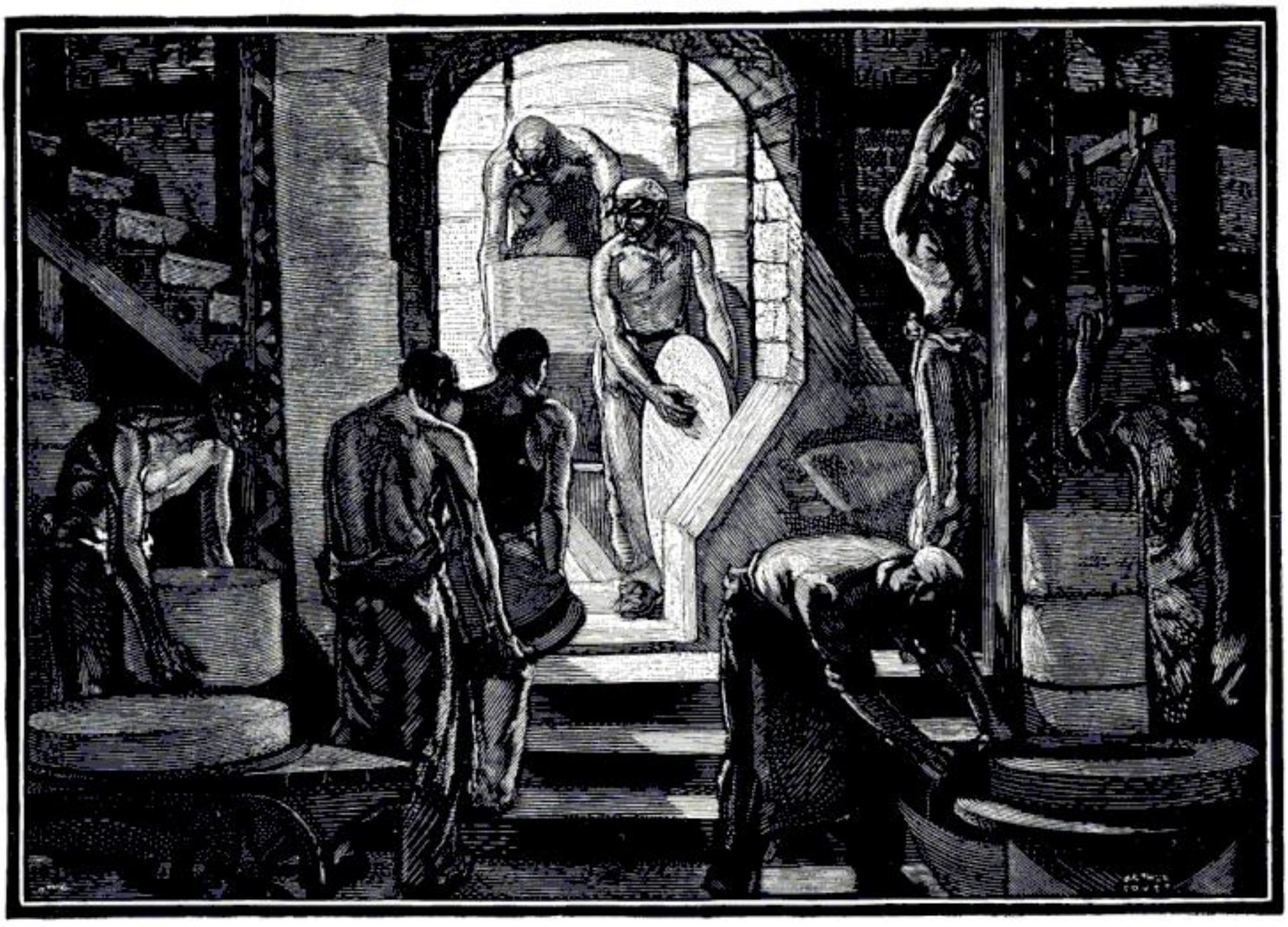

Mural by Arthur Covey. Wood block engraving by Howard McCormick

"Reach for a Lucky - instead of a sweet"

"It's toasted"

No Throat Irritation - No Cough.